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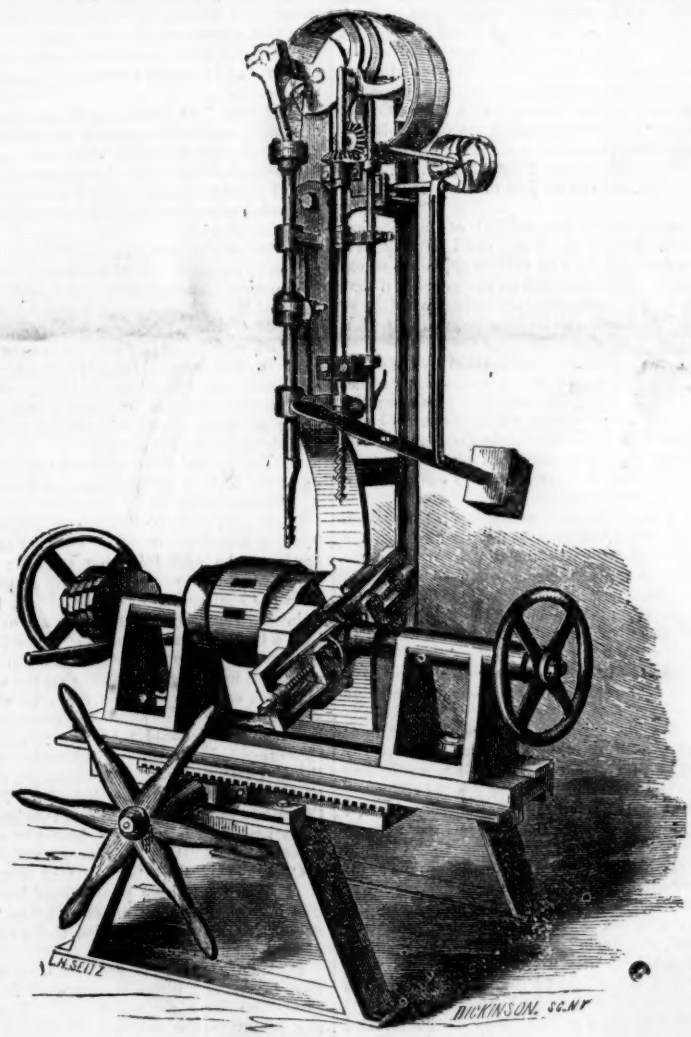
Hub Mortiser and Borer.

In the good old days of yore, when the making of vehicles was all done by hand, and the clumsy and inelegant proportions of a solid circular block of wood was the style for a cart or a chariot, there was no need of a hub mortiser. But modern invention having devised the light and elegant cycles which sustain the various vehicles of the day, ending in the popular velocipede with four wheels, three wheels and two wheels—and even with one wheel, which has lately appeared in Newark, has also devised machinery to manufacture the various parts with great rapidity and at small expense. In this connection we present this engraving, which represents an improved hub mortising and boring machine, which, for simplicity, strength and quickness, has not an equal.

They are used extensively, both in and out of this country, and supersede all others. The machines have been greatly improved, and many of the new parts are not shown. The hub is secured by a universal chuck on one end, and a conical face plate on the other. There are gauges and stays for the dish of spoke, and also for the length of mortise, and index for the number of mortises. The boring attachment is of the most perfect construction.

There can be furnished an attachment for holding ordinary work for mortising, which goes on in place of the heads for holding the hubs. There are two sizes of these machines made, viz., up to 14 inch diameter, and up to 18 inch diameter of hubs.

These machines are manufactured by the Gould Machine Company, office and works Newark, N. J. New York warehouse, 119 Liberty street.



HUB MORTISER AND BORER.

A Water Supply Regulator.

Mr. Charles Geoghegan, architect (of Dublin) has just perfected a very useful invention. The pressure at which the Vartry water will be delivered in the houses of Dublin will not be strictly constant, and may be expected to cause occasional accidents by the bursting of weak or otherwise defective pipes. To obviate this inconvenience various contrivances have been devised; but Mr. Geoghegan's possesses, so far as we can judge, important advantages over those of his competitors. It is self-acting; it costs but 2*l.* or 2*s.* 19*s.*, according to size; and, being of very simple construction, it is not likely, when once set up, to get out of order. The principle of the invention, so far as we understand it, is as follows:—The supply-pipe from the main leads into a closed cistern. When the water in this cistern rises to the maximum height which is compatible with the perfect safety of the house-pipes, the air which occupies the upper part of the closed cistern is pressed through a connecting pipe into a rectangular vessel, called the regulator, one compartment of which is divided by a vertical partition into two compartments, each of which is half filled with water, and which communicate with each other at the bottom. The air which enters at the top of one of the compartments depresses the water therein, and by doing so raises the level of the water in the other. This water in the other compartment contains a float, which, of course, rises with the water and by means of a projecting stem turns a cock in the supply-pipe, and thereby cuts off all further supply and pressure. On the other hand, when the level of the water in the cistern sinks, the compressed air above it expands, and losing a portion of its elastic force, permits the air which is in the upper part of the first compartment of the regulator, and which is in free communication with it by means of the connecting-pipe, to yield to the hydrostatic pressure produced by the head of water in the second compartment. The level of the water in the latter sinks, therefore, and by doing so brings down with it the float, and thereby opens the cock in the supply-pipe. Thus the required supply, and no more than the required supply of water, is maintained without the necessity of any interference of the proprietor or his servants. The apparatus has been exhibited in action in the Corporation-yard, Wine-tavern-street. The manufacturers of the instrument are Messrs. Boss & Murray, of Middle Abbey-street, Dublin.—*Builder, Dec.* 12, 1868.

The Gas Companies and the Board of Health.

OFFICE OF THE METROPOLITAN BOARD OF HEALTH,
No 301 Mott Street,
New York, February 20th, 1868.

In the matter of the application of OSCAR ZOLLICOFFER, *for the modification of the order No.* 425, *dated July* 14*th*, 1868, *of the Metropolitan Board of Health, concerning the business of Manufacturing Gas, at the foot of West* 42*nd Street, New York.*

CONTINUATION OF THE HEARING BEFORE S. C. HAWLEY.

SATURDAY, February 20th, 1869.

Ex-Judge H. C. Van Vorst appeared for the Metropolitan Gas-Light Company.

J. S. Hastings appeared for the Board of Health.

Professor *Henry Wurtz*, called and sworn on behalf of the Metropolitan Gas-Light Company; examined by Judge Van Vorst:

Q. Where is your residence? A. My residence is in New Jersey; my business in New York city.

Q. What is your vocation and profession? A. I claim to be a chemist; call myself a scientific and practical chemical expert.

Q. How long have you studied the subject of chemistry? A. About 20 years, sir, more or less

Q. With what institutions have you been connected in the practice of your profession as a chemist? A. I was at one time in Yale College, as assistant to Prof. Silliman, in what was called the Scientific School at that time, at Yale College; I was Professor of Chemistry in the National Medical College at Washington; Professor of Chemistry in the College at Kingston, Canada; Chemical Examiner in the United States Patent Office, where the subject of gas came before me practically.

Q. Have you given particular attention to the subject of the manufacture of coal gas? A. I have, sir.

Q. Have you studied the subject of its purification? A. I have, sir.

Q. Have you observed the subject of purification practically? A. Within the last year I have spent a considerable amount of time on various occasions in examining processes of purification on the ground, if that is to be understood as studying it practically.

Q. Are you familiar with the lime process of purification—dry lime. A. I am, sir.

Q And with the method of purification by the oxide of iron? A. Yes, sir, so far as a gas chemist can become familiar with it in this country, I presume: the only place that I am aware of where it is used being the works of the New York Gas-Light Company in this city, which I visited on two occasions when they were using the process, and had permission to examine into the minutiæ of its workings.

Q. The dry lime process of purification is that which is in use in the United States, is it not, sir? A. So far as I am aware, with the exception of two or three gas works in which the wet lime process is used.

Q. One is in Boston, is it not? A. One is at Boston and one, I think, at Providence, but the last account I received from the Providence Works they were proposing to substitute the dry lime.

Q. When was that? A. Quite recently—within a fortnight—I heard the fact; I have no special knowledge however in the matter.

Q. I would like to ask you what are the results of your observations of the lime and iron processes for the purification of gas; you may speak of it in a scientific point of view and also in a sanitary point of view. A. With regard to the scientific points involved, sir, I would remark, that I believe the ground has been so thoroughly gone over by Prof. Silliman, that I should have little to add, and the more especially so as a great portion of the same ground has already been gone over by me in print, and, therefore, I would propose to present a copy of a report made by me to the Manhattan Gas-Light Company during the last summer, made in manuscript, and which they printed about the first of December, or the latter part of November last, and of which I have some printed copies here.

Q. Will you produce a printed copy of that? A. I have several here.

(Professor Wurtz produced a printed copy of the report, which was offered in evidence)

Q. In that report do you discuss the claims of the two systems of purification—the lime and the oxide of iron? A. I do, sir; I would remark with regard to this report, that in this report there is brought forward some account, intelligible at least to gas chemists, of the new process which has been spoken of here previously by experts.

Q. At this hearing? A. Which has been spoken of previously by other experts, not at this hearing, but a previous hearing; the process of the Manhattan Gas-Light Company; there is, however, no specification given of this process; as I understand the meaning of the term specification, in a technical and practical sense in fact such specification was purposely omitted by me; I did not feel authorized or called upon to present such a specification.

Q. Specification of what? A. This method of purification; such a specification as would render it possible for a gas engineer to put it into practice.

Q. Do you mean of the Manhattan Company's process—of ventilating the effete lime? A. Yes, sir; the question may be of the ventilation of effete lime; nevertheless the principle of the process could be understood by gas chemists, and I should mention that this pamphlet has quite recently—within six weeks—been republished, or copied by the London *Journal of Gaslighting*, and has consequently actually become a part of the current literature of gas.

Q. When was this report of yours published? A. So far as my memory serves, it must have been about the 20th of November, 1868, that it was printed; it was circulated though, I believe, only in a private way.

Q. Have you any reason to alter your opinion now, as expressed in this report made by you? A. The only essential addition that I would suggest is to add to the substances which are extracted largely by hydrate of lime from the gas, the constituent called naphthaline, which is not extracted to so large an extent by oxide of iron; allow me to read one of the paragraphs from this pamphlet.

Q. Which page is that? A. On page 9; I present in the form of some conclusions, in one paragraph, this one: "It thus appears that of those constituents of crude coal gas which may be viewed as contaminations, and whose separation is desirable, there are no less than four of the most objectionable, which, while distinctly under the control of the lime process, cannot be shown to be separable by any recognized or reliable chemical or other agency residing in oxide of iron; these four are carbonic acid, ammonia, bisulphide of carbon, and phenol;" and to these I would now venture to add naphthaline.

Q. These four contaminations, then, you say, are distinctly under the control of the lime process, and are eliminated by it; is that so? A. The results of the examination appear to show that; I would also add, I find in my notes that I mention the nitrogenous and sulphuretted odorous matters of the gas which are complained of.

Q. What do you say about those? A. I have no reason to suppose that the oxide of iron retains these in any form, although they are largely retained by hydrate of lime.

Q. Well, then, I suppose you mean that the oxide of iron is a very imperfect purifier, a low purifier with regard to the carbonic acid, ammonia, bisulphide of carbon,—phenol, and naphthaline you would add? A. Naphthaline, and at least a portion of these specially odorous compounds which form the subject of complaint by the public.

Q. You adopt that pamphlet now, then, as a part of your testimony in this case and offer it as such? A. Substantially.

Q. Have you said all that you designed to say about it, in a scientific point of view, or is there anything further to be added in that respect; if not, then you may proceed to state the result of your observations from the sanitary point of view? A. I would add the following remark:—in the present condition of the subject, a fundamental consideration for the gas chemist is, that before any final decision as to the adoption of a method in a large gas works, on the smooth workings of which so much depends, a precise chemical solution should be arrived at of all the questions and problems involved; this would take time; realizing this I have recommended it to the gas companies, and especially to the Manhattan Gas-Light Company; and I might add, that the chemist of the Board of Health, Professor Chandler, was invited to join in this investigation; this investigation has not yet, however, made much progress; other matters have intervened.

Q. What is the state of that investigation now? A. I regard all these proceedings *here* as a portion of that investigation, and an essential portion, an important portion, a valuable portion, and a fortunate portion, of that very investigation.

Q. What results will proceed from it, in your judgment? A. The ultimate results, I doubt not, if it is carried on in a right spirit, and with diligence, will be the removal—the entire suppression of all the unpleasant consequences resulting usually from the impurities in the purification of the gas, and the improvement of the quality of the gas at the same time.

Q. Will you speak of the result of your observations of the lime and iron processes for the purification of gas from a sanitary point of view? What are the advantages or objections to each process? A. First, I would prefer to make one or two general remarks. It is understood by myself, and, I believe, by the public generally, that formal and deliberate accusations have been brought against the Metropolitan Gas-Light Co., to the effect that they have been guilty of negligence affecting the health and the life of portions at least of the community. I regard these accusations as pure phantasy, while at the same time I would not deny the existence of a bad odor by any means. That would be absurd; quite as absurd in the opposite direction; neither would I deny the necessity of exercising all due diligence and exhausting science in preventing the escape of this bad odor—a subject which is occupying the attention, I may say, of gas chemists all over the world at the present time, but which is by no means satisfactorily solved, unless we may regard the process so very recently developed by the Manhattan Gas-Light Company as a solution. I may say, that I individually do regard that as a solution, and so stated in the pamphlet referred to; and the other gentleman brought forward as an expert concurs, it would appear from his testimony, fully with me in this. I would add, that I have never met with any evidence pointing towards the truth of this accusation of any deleterious or detrimental action upon health, or any injury to health or danger to health, arising from the emanations from gas lime under ordinary circumstances. I have remarked that I consider this is a fortunate investigation. I consider it fortunate to the Metropolitan Gas-Light Co., because it gives them an opportunity to purge themselves from these accusations of having injured the public health and endangered life. These accusations, if true, would really amount to accusations of a criminal negligence. I might add, that the experts who have testified in the case have already been attacked, by implication in the newspapers, for aiding the Metropolitan Gas-Light Co., and that is one reason why I make these deliberate remarks. Now, with regard to the sanitary bearings. I will take the several substances in order: First, carbonic acid. The view has been presented in the course of this investigation, that a small proportion of carbonic acid in the gas is of no importance in a sanitary point of view. I would say, in my opinion, as an expert, this remains to be proved, and that the probability is that anything which impues the rapid and complete combustion of the gas in a confined room is extremely likely to be injurious to the health of the occupants of the room. To ammonia the same remark applies as to this; but at the same time I do not regard it as of any very great importance. Professor Silliman has already suggested an important beneficial action which ammonia exerts when left in the gas, in neutralizing toa certain extent the products of the combustion of sulphur, which always remains in the gas in a greater or less quantity.

Of sulphide of ammonium. This is the most important constituent with which we have to deal with, doubtless, in a sanitary point of view. Both the lime and the iron processes doubtless extract these completely from toe gas when properly applied. The very fact that the oxide of iron process extracts it at all is a sufficient answer in the mind of chemists to the allegation that has been made that there is free sulphuretted hydrogen in the gas. It is difficult to understand how oxide of iron could absorb sulphuretted hydrogen—free sulphuretted hydrogen from the gas, except in the presence of an excess of ammonia, and then it becomes not free sulphuretted hydrogen, but sulphide of ammonium. The consideration of the sulphide of ammonium then is narrowed down to its effects in the material used for purification, and its after effects upon the atmosphere. In the case of oxide of iron purification. The effete iron when taken out of the purifier is believed to contain a large quantity of sulphide of iron. It may contain some ammonia. As Professor Silliman has already stated it is well known that hydrated oxide of iron does absorb ammonia to a certain extent, though not by virtue of any definite chemical affinity that has ever been pointed out. As I understand it, just as clay, dust, or any finely divided material, as however, all the sulphide of ammonium is converted by the oxide of iron into sulphide of iron and free ammonia, and chemists would expect that some of the ammonia set free would travel on from the iron purifiers with the gas. I am not aware, however, that the chemical points involved in these considerations have been worked out satisfactorily. I am drawing inferences from theoretical considerations in a great measure. When the effete oxide of iron is exposed to the iron, then we have a mass of sulphide of iron, whic immediately attracts oxygen from the air, producing heat and burning. There is a danger here which seems inherent in the process; that tho heat may become so high as to set fire to the mass of sulphur, and sulphurous acid would be produced by the combustion of the sulphur. This danger probably increases in proportion as the mass has been revivified and re-employed. It is alluded to in some of the works upon the subject, as a difficulty now undergoing investigation, and being probably gradually mastered. I have here a work recently published by Zerah Colburn, on the "Gas Works of London, in which he states, on page 60: "Sulphuret of iron precipitates its sulphur on exposure to the air, and again combines with oxygen, occasionally with such energy as to take fire." On page 55, "the precipitation of sulphur and the resumption of oxygen are occasionally so rapid, especially when the material has been used a few times, that it smothers and actually enters upon active inflammation." In the latter case the sulphur vapor is almost overpowering. On page 57, "At the Commercial Works, however, Mr. Jones has his apparatus in readiness, and may have already commenced, indeed, to revivify Hill's oxide in his purifiers." The date of this is 1862.

Q. The author then is speaking of the method of purification by oxide of iron, is he not in this instance? A. Yes, sir, in London. This is a practical work very recently published, and the impression gathered by a gas chemist is, that the subject of the revivification of oxide of iron is not yet reduced to such a cerhainty as to avoid with certainty this difficulty of catching fire of the great quantities of free sulphur which are thrown out of these purifiers, and the consequent diffusion of great quantities of sulphurous acid throughout the neighborhood of the gas works. In the case of the lime purifier the sulphide of ammonium is largely absorbed as such, and appears to form a compound with lime, or with sulphide of calcium. As yet not investigated or understood by chemists. On exposure to the wir this material undergoes oxidation also. The main substance given off being free ammonia, which carries with it, however, some sulphide of ammonium. I have heard no evidence yet brought forward, and I have met with no evidence in all my readings of any deleterious effects from sulphide of ammonium. I have here a sample of sulphide of ammonium. Any gentleman can test the effect of it upon his nose and lungs by actual experiment. Here is a very concentrated solution of sulphide of ammonium, containing, as it almost always does, when it has been standing some time, free sulphur in solution, indicated by the yellow color and some sulphide of ammonia. I am enabled also to present a solution containing sulphurous acid, upon which some remarks have been made here, and upon which I have some further remarks to make, as an exhibit to be tested by gentlemen who are now familiar with it. The effect upon the nose and eyes is very distinct, though the odor is not very strong, and the effect upon the throat is very marked in producing a choking sensation, and if persisted in for a few inhalations, very violent fits of coughing are produced. This gas is simply the same as is given off by a brimstone match, familiarly known as fumes of burning sulphur—brimstone fumes—and the suffocating quality of which every one is familiar with. I shall haue more to say about it subsequently.

The next substance which I wish to speak of is phenol. I am not aware that phenol is absorbed by oxide of fron. I am not aware either that its presence in the gas is detrimental either to the illuminating power, or in a sanitary point of view, but it is well known to be absorbed with some considerable power by lime having an affinito for lime by virtue of its analogy to alcohol, and forming a weak compound, somewhat similar to what are knewn as alcoholites. When the effete lime is exposed to the air the phenol is doubtless given out again, sooner or later, from the absorption of the carbonic abid by the lime, to the displacement of the phenol. I should consider it preferable that it should be given out in this way, rather than to be distributed with the gas to the consumers, as its odor is disagreeable to most persons, and extremely persistent and has the nature of adhering to substances for a long time, as everyone who has ever had the toothache knows familiarly, who has used it for curing toothache; it is generally called creosote, although it is not creosote but it is sold for creosote, and used for the same purposes, and is similar to it. Gas containing phenol when leaking as gas is very likely to do, or let out into the atmosphere, would doubtless have a tendency to leove a persistant odor more than well purified gas. Phenol is accompanied by other substances, one of which is known by the name cresol, which has a somewhat different odor, but at the same time very persistent.

The next substance I wish to speak of is naphthaline. Naphthaline appears to be absorbed largely both by the oxide of iron and by the lime. There is always danger of too much of it being absorbed by the gas. Its illuminating power being very high, one of the evils of over purification is the abstraction of too much naphthaline from the gas, and the impoverishment of it. At the same time it is dangerous to leave very much naphthaline in the gas, particularly when the gas is not of a very high illuminating power. Poor gas containing much naphthaline frequently would deposit naphthaline in the main, and endanger the supply to the community by choking the mains; hence I should prefer a process which would abstract from a very rich gas enough naphthaline to prevent this danggr, and not abstract enough to impoverish the gas. Gas engineers have generally found the lime process to answer these requests. When a poor gas is in question experience has shown that naphthaline has a tendency to deposit in any case.

The next substance is bisulphide of cgrbon. There is much difference of opinion as yet among gas chemists about the relations of this substance to gas, which I attribute to the overlooking of many of the results of the errlier investigators of the substance. I have gone back to those oider writings—those of Berzelius and Zeise on this subject. Not to go into the chemistry of the subject in detail, I will merely say that we have here evidence sufficient to justify us in believing that hydrate of lime extracts all the bisulphide of carbon from gas.

Q. How is iron, the oxide of iron, acted on? A. There is no evidence of any action upon bisulphide of carbon by this.

Q. No affinity between the oxide of iron and the bisulphide of carbon? A. Not that I am aware of. Bisulphide of carbon is an especially dangerous and injurious substance in gas, as it is not detectable by any simple means—as lead paper for instance. Second, it is inodorous. When pure, lmost inodorous. In the atmosphere it decomposes and develops an insupportable odor, the cause of which is not well understood, probably owing to the development of hydrogen compounds; as I may say Prof. Silliman has recently pointed out in an item published in the *American Gas-Light Journal*. Bisulphide of carbon, when burning, is converted into sulphurous acid; the sulphur in it is converted into sulphurous acid. There is no reason to believe that it does not undergo perfect combustion in gas. The combustibility, so to speak, of sulphur, may be said to be greater than any other of the constituents of gas. It probably is burned first into sulphurous acid.

The next class of substances are the odorous compounds. These pass chiefly into the tar in all cases. It the gas be scrubbed with water, after it is evolved from the retorts, as it is by the Metropolitan Gas Light Company, more tar is deposited, and my observations have convinced me that I may say that these odorous compounds are condensed at that stage of the operation. Inferring from the well-known fact that woolen substances have great power to condense these odorous materials—these persistent odorous substances which are found in smoke, say for instance—tobacco smoke; inferring from this that an instructive experiment might very readily be made; I took a blanket shawl which I have here, and which any one will see at a glance is very appropriate for the purpose, and spread it out in the fumes from one of the fouled purifiers of the Metropolitan Gas Company, which had been opened, and was giving off this stench very perceptibly. This shawl I carried with me and wore it a part of the time afterwards, and tried to distinguish at intervals the odor which I supposed would be absorbed. I could not recognize any such odor in the course of, to the best of my recollection, about three hours afterward. I do not mention this as a conclusive test. It is only a very imperfect test. I judge from it, however, that there is much less of this intensely odorous substance evolved from these lime purifiers, when the gas has previously been scrubbed by water, as is practiced by the Metropolitan Gas Light Company; for the reason that on previous occasions, when I have been exposed to the effluvia from opened lime purifiers, or even from that which generally floats from the atmosphere of a purifying house to some extent, I have retained the smell about me for twenty-four hours, as near as I can recollect. These were instances where the gas had not been previously scrubbed with water. In previously scrubbing, the impurities had been condensed and did not reach the lime. I may say that I was surprised by the result, because I expected on this instance to carry the smell with me. I supposed this shawl was a peculiarly favorable fabric to absorb and retain it. I should conscientiously add that I have heard that the New York Gas Light Company also scrub their gas as it comes from the retorts. I should like to ask Prof. Chandler whether he knows this is a fact or not?

Prof. Chandler—I believe I do.

Prof. Wurtz—And this would account for the comparative absence of these concentrated odorous substances, when the iron oxide purifiers are open, and account for the discrepancy between the statements made by experts here, with regard to the comparative absence of these foul odors from the effete oxide of iron of the New York Gas Light Company, and the opposite published statements made by English authors, Dr. Bowditch and Dr. Letheby, for instance. This, however, has no bearing upon the question as between the oxide of iron and the hydrate of lime process. This is a question apart. It has, however, a bearing upon the accusations that have been made against the Metropolitan Gas Light Company for not exercising due diligence, and not taking due precautions to avoid offending the noses of the public. The gas itself is another material given off when the purifiers are opened in both cases. This contains carbonic oxide, a dangerous and well-known violent poison. I have not found that it is pretended, however, by any one, that the carbonic of oxide given off from open purifiers, has ever produced any injury to anyone. The supposition is simply absurd, from the fact that it is instantly diffused radially, and that its toxical efficiency must decrease, as the light from a candle decreases, for instance, by radiating from the centre, so that at a very short distance it becomes so diffused and so diluted, that no chemist could detect it in the atmosphere any longer. With regard to sulphide of ammonium, I would suggest that the same remark applies; that the dilution of the material, in diffusing through the atmosphere, must increase as the square of the distance, not simply as the distance; consequently, in a very great geometrical ratio. This was shown by the experiment, the results of which have been already exhibited; in the specimens of lead paper, seventy-five feet from the purifying house when the purifier was in full process of oxidation. From a freshly open purifier, at the distance of seventy-five feet, the delicate test lead paper no longer detected sulphur in the atmosphere. The question between the lime and the iron process seems, to me, to narrow itself down as between the alleged nauseating effects of sulphide of ammonium, and the admitted irritating and suffocating effects of sulphurous acid, although in minute quantities. Those who have tested these two materials here, will be able each to form his own judgment upon these two points. I am willing to admit the nausea, though with me the effect is exactly the opposite. Tobacco smoke, for example, is said to produce both effects—the nauseating and the stimulating, upon different persons and also upon the same person at different times, I believe. Yet, it is scarcely proceeded against as a nuisance dangerous to health, unless inflicted to an excessive degree. Yet a word or two more with regard to sulphide of ammonium, before I leave it. It may not disappear simply by diffusion. The chemical books might be extensively quoted from, to show that it is an admitted fact that sulphide of ammonium oxidates in the air, forming hyposulphite of ammonia I have in my notes a references to Gmelin's Xand-book, supporting this statement, but as I am confining myself to the sanitary points I shall not present chemical references. I wish to remark here, however, that this would assist the process of diffusion, in actually destroying the sulphide of ammonium very rapidly, but I wish more particularly to point out that in the open atmosphere there is ozone, which very quickly destroys sulphide of ammonium. In the confined space of a room there is no ozone. Here is an important point which has not been considered by many of the chemical experts who have written upon this subject. This same remark might apply to the disappearance of sulphuretted hydrogen if it were set free from the fouled purifiers when opened. But I should regard that question as having been fully disposed of, it having been fully conceded that the effluvia from the effete lime contains an excess of ammonia, and no free sulphuretted hydrogen, and I have also presented, myself, evidence drawn from the iron process itself, that no free sulphuretted hydrogen can be present, as such, which would be absorbed with certainty by the oxide of iron according to any principle that I am acquainted with.

The main point remaining with regard to the sanitary bearing, relates to the nature of sulphurous acid. I must admit, in giving conscientious evidence, that I differ somewhat from many chemists of my acquaintance, on the poisonous power of sulphurous acid. I believe that it is underestimated. I believe that there is a class of men who are constitutionally insensible to the usual effects of sulphurous acid upon the mucous membrane of the air passages. Individually I am an example, and I believe in common with a great majority of mankind, of extreme sensitiveness to the action of of the most minute quantities of sulphurous acid in the air. There are proofs however on record of the poisonous nature of sulphurous acid in very minute quantities which can be cited. I am referring for instance to the frequent and protracted cases of litigation, particularly in European countries, concerning the effluvia given out by metallurgical furnaces, copper furnaces, particularly, the deleterious effects of which spread for miles around. I found that even with this radial diffnsion and this decreasing inversely as the square of the distance, of the quantity in the atmosphere, yet sulphurous acid is still detrimental. In conversation it has been remarked to me that I overlooked, in taking this view, the presence of arsenic sometimes in these effluvia. I did not overlook it. Arsenic is given off in the form of arsenous acid, which is not a gaseous substance. It is a solid substance, which is very quickly deposited and cannot diffuse itself to a distance of miles. Yet there is abundant evidence on record of the diffusion of this actually poisonous influence, both upon plants and animals about those furnaces where sulphuretted ores are burned—are roasted, to the distance of several miles. In one place a nobleman's park in Great Britain was entirely destroyed, root, leaf and branch. These facts must be explainable. I explain them in this way. Sulphurous acid is what is called a cumulative poison, in the language of toxicologists. It is absorbed by water—by moisture and moist surfaces, with gradual accumulation upon such surfaces. It is absorbefl by rain and deposited upon moist surfaces. In this manner it destroys the leaves of plants doubtless. It is converted into sulphuric acid by oxidation, to some extent at least, slowly—probably very quickly in the open atmosphere, by the action of ozone. I am verging npon the chemical points so that I will not pursue this further. I think I have said sufficient to illustrate my views upon that head. My belief is that the use by the last generation, so universally, of brimstone matches, has given rise to a dangerous indifference to the inhalation of sulphurous acid in small quantities, and that the next generation will recognize the view I have taken of the question, that it is one of the most toxical gases, even in small quantities, to whose

attacks human beings are liable in ordinary life. I would add that I am told that the French laws have prohibited the evolution of sulphurous acid from the smelting furnaces into the atmosphere at all, in consequence of their recognition of the poisonous character of this gas. In the pamphlet which I have presented in evidence, the effect of sulphurous acid when set free in a confined space like a room, for instance, are alluded to, in the case of the Metropolitan Under Ground Railway in London, in which it is averred on good medical authority—the authority of medical experts called in the trials which took place—that the sulphurous acid was the cause of the deaths that have occurred, and in the course of this trial Doctor Letheby asserted as the results of his experiments that one part of sulphurous acid in 100,000 of air, is perceptible to the taste and will produce coughing. Dr. Odling, in one of his earlier statements on this subject presented some views which have been cited here, to which I strongly object in many ways. The article which I allude to has been cited in the *New York Times* of Feb. 12th.

Q. The extract from Dr. Odling's lecture? A. Yes, sir.

Q. Very well, what do you say about that, Professor? A. Dr. Odling makes a calculation here, which I have not critically examined, but he presents the point that the fact that the sulphurous acid porduced is diluted, with a thousand times its volume of carbonic acid, it is liable to render it less poisonous. Dr. Odling has overlooked the view that I have presented of the cumulative character of sulphurous acid as a poison; and taking that into consideration I would regard its dilution with carbonic acid merely as calculated to intensify its toxical action and make matters worse. The depressing effect of carbonic acid upon the system is well known, and if you add sulphurous acid, with the irritating effects of the sulphurous acid upon the air passages, you have a combination of circumstances very unfavorable to health. There is no doubt that in the upper portions, as Professor Silliman has already stated, of crowded assembly rooms, where gas is burned extensively, such as theatres, churches, ballrooms even, and many other similar places, these injurious gases produced from the gas burners, would exist in much larger proportion than Dr. Odling admits here. That is another point which he does not take into consideration. His supposition that the amount of ammonia ordinarily existing in the atmosphere can neutralize 20 grains of sulphur in the gas, strikes me as simply absurd. I have calculated that for neutralizing 20 grains of sulphur, if converting it into sulphate of ammonia is a neutralization, it would require 21 grains of ammonia. Every chemist who knows that an ordinary atmosphere contains an amount of ammonia almost infinitesimal, will see the unreasonableness of Dr. Odling's suggestion here. One hundred cubic feet of gas containing 20 grains of sulphur—or 45 as Prof. Chandler has stated, I think, was contained in the New York Gas-Light Company's gas purified by the oxide of iron—100 cubic feet of such gas would require very nearly 50 grains of ammonia to convert its sulphur into sulphate, or sulphite of ammonia.

Q. I want you to state in as few words as you can the inefficiency of the oxide of iron process of purification to eliminating these contaminations, and the efficiency of the lime process to eliminating them—briefly, and as it is affected by this question of sulphurous acid of which you have been speaking. I wish a practical application made of what you have said there of the poisonous character of sulphurous acid, and how it is affected by those two systems of purification, or how the two systems of purification bear upon it? A. It is in evidence from the researches of chemists that bisulphide of carbon, as well as the sulphide of ammonium and other sulphuretted compounds detectable by lead paper, should be completely absorbed by hydrate of lime. There is no direct evidence that oxide of iron can absorb all the sulphide of carbon.

Q. Now then, the bisulphide of carbon and the sulphide of ammonium being left in the gas, after it has been subjected to the action of the oxide of iron, where and under what circumstances do other injurious effects present themselves? A. When the gas is burned, according to the experience of all mankind.

Q. When the gas is burned in dwelling-houses or public places the presence of these contaminations is then experienced in the form of what? A. Sulphurous and sulphuric acid; the weight of evidence is so great on that point as to make the facts notorious.

Q. And which are destructive to property? A. Destructive to property, irritating to the air passages of most persons, and peculiarly so in crowded places, and especially in the upper portions of the atmosphere of such crowded places.

Q. Now then, what kind of gas would you call that to be which exhibits the presence in it of from 21 to 45 grains of sulphur per 100 cubic feet? A. I should regard such gas as objectionable; I should prefer such gas as was purified down to 20 grains, or as low as possible; down to 10 or 12 grains, as the Manhattan Gas-Light Company, for example, claim to purify their gas.

Q. I will ask you the question whether you consider the emanations and exhalations from the spent lime, when the purifiers are open, as deleterious to health? A. I cannot view them in any light which will justify such an estimation of them; I am not aware of the slightest evidence which would justify any such view.

Q. Now then, you have been present at the New York Gas-Works—you have been at the New York Gas-Works where the oxide of iron process of purification prevails? A. I have, sir.

Q. Have you been there when the purifiers were opened and the foul iron was exposed to the air? A. I have.

Q. Will you state, if you please, whether they gave forth any odor, and if so, what was the character of them? A. I perceived the characteristic odorous substances which have been the subject of complaint, but not to so great an extent as I have perceived them on other occasions about large Gas-Works.

Q. Are they not inevitable—the presence of unpleasant odors when the purifying material, whatever it may be, as far as your experience extends? A. I have seen purifiers opened at large Gas-Works——

Q. I mean such as you have spoken of? A. I have seen purifiers opened in large Gas-Works when these odors were so slight that they might be called imperceptible.

Q. What Gas-Works was that? A. In the Manhattan Gas-Works.

Q. That is where this new system of ventilation of which you have spoken prevails? A. Where the effete lime was thoroughly ventilated by the passage of the air through the closed purifier, and the mass converted into a porous substance something like chalk and inodorous; a specimen of it has been produced here.

Q. You have visited the works of the Metropolitan Company? A. I have on several occasions.

Q. I wish you would state your general conclusion as to the management, manipulation and products of the Metropolitan Gas-Light Company? A. I have made several visits. One of them was on the 30th of January, 1869, when a fouled purifier was opened especially for me at 10.30 in the morning. This purifier was 20 feet by 20 and with six tiers of trays. It contained between 200 and 250 bushels of lime, and very nearly 1,000,000 feet of gas had been put through this lime during the 24 hours immediately previous; atmosphere of purifying-house strongly ammoniacal and distinctly stimulating.

Cassidy, the foreman, stated that he had been six years in this purifying-house and seventeen years in all in the same employment, having come from the Manhattan Works; was 56 years old, appeared robust and with healthy and florid complexion; stated that the men under him were all strong and uniformly healthy, but suffered from temporary irritation of the eyes from the strongly ammoniacal atmosphere when the boxes were being emptied gas not over purified, as it still indicated small traces of sulphur and ammonia."

I would remark, that I ascertained on that occasion that the time of cleaning these large purifiers was about one hour, which is a very short period, if I am not mistaken, and indicates diligence in getting their material out of the way as much as it can be. I collected some samples upon that occasion which have already been exhibited here. Subsequently I made a visit together with Professor Silliman, on which we made those important tests with lead papers and made a thorough examination of the works. I agree with Professor Silliman in the general conclusion that the management of the Metropolitan Gas-Works is quite as careful and cleanly as is compatible with the working of so large an establishment. Excepting this one point, which might be excepted, relating to the ventilation of the lime in the purifiers, which I regard as entirely extraneous to this question; a general answer would be that the management and manipulation of the Metropolitan Gas-Works is as careful and as cleanly as that of any other large gas-works which I have visited.

Witness: I would ask the counsel whether he wishes the question to relate to the future course—whether he wishes to ask my opinion as an expert as to what should be the future course of the Metropolitan Gas-Light Company.

Judge Van Vorst: No; that is not in relation to this question.

Q. You have stated that the oxide of iron has no affinity for, and does not remove the bisulphide of carbon, is that so; what would be the effect of subjecting the gas, after the oxide of iron had acted upon it, to the hydrate of lime or wet lime; what effect would that have upon it; what office would that agent perform, and how would it affect the gas to be delivered? A. It would depend upon the quality of the gas; it would depend upon the richness of the gas.

Q. What effect would it have upon the illuminating power of the gas? A. It would decrease the illuminating power of the gas inevitably; it would amount to over-purification, technically so-called by gas managers.

Q. And over-purification has a deleterious effect upon the gas, has it not? A. Upon the illuminating power of the gas.

Q. Then there is such a thing as over-purification of the gas? A. There is.

Q. And that would be the effect of subjecting the gas to this double method of purification of the iron and lime afterwards? A. It would.

Q. Now, Professor Wurtz, I desire to ask you, as an expert, your opinion as to the suggestion that has been made to substitute the use of the oxide of iron for lime by the Metropolitan Companies as a method of purification? A. I think it is incumbent upon gas chemists and upon the whole community to be taught by past experience in deciding such questions; we are now repeating a chapter of history here—a chapter of history which has been passed through by the gas manufacturers of Great Britain more particularly, and even to some extent by our largest company—the Manhattan Gas-Light Company. Complaints relating to this so-called nuisance, from municipal authorities, have been abundant in all civilized countries where large cities are lighted by gas. In England this was carried to such an extent that the gas companies were brought up so often as nuisances before the Police Courts, that they adopted the use of the oxide of iron, thinking that in that way they would get rid of a portion of the smell, and make matters better. The tendency, however, at the present time, is to go back again. The first result was that the amount of sulphur increased in the gas. I wish to add here with regard to bisulphide of carbon that it is considered by gas chemists as a very slippery thing. The same coal from the same heap varies very greatly in its product of bisulphide of carbon; sometimes the quantity being so very great that it is stated the gas will give off the smell of brimstone matches. The point which I wish to bring forward is that bisulphide of carbon may occur in gas occasionally to a very large extent owing to causes as yet unknown. Sometimes a coal which is found by analysis to be comparatively free from sulphur will give a very sulphuretted gas, from which the sulphur cannot readily be removed by the ordinary modes of purification. Until we know more about bisulphide of carbon, I think I would be cautious in substituting for the agent—the hydrate of lime, which is known to absorb it—any other agent which is not known to absorb it.

I wish to make one or two further remarks. I have already spoken of the danger also of oxide of iron catching fire, which seems to be spoken of as one not yet entirely mastered by our gas chemists.

Q. Is there a danger to be apprehended from the oxide of iron catching fire? A. Where a vast mass of it is used as would be in a large gas-works like the Metropolitan and is kept lying about, I should regard it as a danger which must be taken into consideration in advance of any extended or continued series of experiments upon the subject.

Q. What is its liability to take fire attributable to—to the presence of what in the iron do you attribute that? A. To the presence of sulphuret of iron or sulphide of iron. The effects of its taking fire is to give off large quantities of sulphurous acid which would render the atmosphere of the neighborhood of the works intolerable.

Q. That would be the effect of it? A. Yes, sir; with regard to the management of the Metropolitan Works, there is another point I find that I noted down in reference to statements that have been brought forward, which I believe are rather ancient, being taken from Ure, of men having been suffocated in sewers, wells, and pits, and so on, by the emanations from waste lime. I would simply remark, that the only reasonable inference to be drawn from this, is that waste lime should not be used in that way to fill up such places; that it should be managed precisely in the way that the Metropolitan Gas-Light Company do manage it. It should be spread out in the open air so as to become ventilated and oxidized, and the sulphur compounds destroyed, so that they cannot collect together in depressions and cause danger and produce deaths in that way.

Q. I ask you whether you observed in the neighborhood of the Metropolitan Gas-Works any causes which would be likely to produce contaminating or deleterious odors. A. On the occasion of one of my visits I smelled a very putrid odor which I was informed proceeded from an establishment for the boiling up of the carcasses of dead horses, the location of which was pointed out to me, and from which the wind at that time blew directly, as I observed.

Q. Where was that establishment? A. At the foot of 38th street, three blocks south.

Q. Was it such an odor as would be likely to proceed from such a cause as that? A. I should have said I perceived it on two occasions. On one occasion Professor Silliman was with me, and he pointed it out to me, and we both remarked its entire distinctness from the odor of the gas works. The wind was blowing in such a direction that no smell could come from the gas works.

Q. Was it an odor that would be deleterious to health? A. I should think it was an odor decidedly deleterious to health. There is another large establishment that is known by the name of a piggery. I did not go inside of it, but I infer also from the odor, which was the usual odor of a pig sty.

Q. How near? A. Next door to the Metropolitan Gas Works.

Q. It extended how far? A. It extended nearly the whole of the long side of the block between 11th and 12th avenues. I wish to add, that I have consulted some of my chemical friends about this question as to the character of these odors, which are known to spread through the city on certain occasions, and I have found several who have concurred with me in the idea that they were not always from the gas works; that there are odors which spread over New York from other sources, and which they recognize as such, sometimes as the smell of putrid matter. I think the gas works have received the blame of all these things. Injustice has been done them to that extent. I would add, I believe it comes under the present head that we are talking of, that there would be considerable difficulty and injury in at once arbitrarily changing the system in use by the Metropolitan Gas Works at this season. It could only be done at a season when the consumption of gas is at a minimum.

Q. What season is that? A. In the spring, I suppose—in April.

Q. Have you stated already when the process of ventilation of effete lime in use by the Manhattan Company was first made known to the public? A. It was first really made known to the chemical public by its publication in the London *Journal of Gas Lighting* during the last month—the preceding month of January.

Q. Of this year? A. Of this year. I has really not been made known to the general public in such a form as to be available practically at all.

Q. There have been no specifications of it published? A. There have been no specifications.

Cross-examined by *Mr. Bliss:*

Q. In your opinion, is there any necessity for the Metropolitan Gas Company to conduct its operations of the manufacture of gas in a way that gives off the offensive odors that are given off when its purifiers are changed? A. Not permanently.

Q. Had they on the 14th of July last or the 15th of July last gone to work to remedy the offensiveness—could it not have been done long before this time? A. Well, I am not really bound to answer a question which relates more especially to gas engineering. I do not feel competent to answer. The impression on my mind is, that they might have done it. It is merely an impression; that is, if they had the specifications before them.

Q. Is not this process of purification by ventilation a modification of Palmer's process, which has been known for a long time? A. I should say not. It is an improvement—an additional attachment or appendage to the Palmer process, and throws out also, some portions of the Palmer process.

Q. Is it a patented process? A. I do not know whether it is or not. I have no right to know anything about that.

Q. Is there any difficulty in any other gas company gaining the means necessary to put that process in operation—I mean by inspection there? A. There is no difficulty in their gaining a knowledge, I presume. I know of no such difficulty. The Manhattan Gas Light Company have offered no obstacles to inspection so far as I am aware, although I am not familiar with their police regulations, but as to their being able to do it, that depends upon conditions that I am totally ignorant of.

Q. What conditions? A. That was answered in my previous answer—as to whether it is patented, or is going to be, or is caveated.

Q. Suppose the chemist of the company goes there to-morrow, can he get access to the information necessary to put this process in operation? A. I cannot answer that question; I have no authority to answer for the Manhattan Gas Company.

Q. Then, if there are no means, to your knowledge, of putting that process in operation, we will leave that out of the question? A. I do not know that I am to decide as to whether we will throw that out of the question or not.

Q. How long has that process been in operation in the Manhattan Company? A. I am not familiar with the history of it, except in a very general way, and by hearsay. I have been informed that in its present form, that it has been in use some two or three years.

Q. At the Manhattan works? A. Yes, sir. In a form somewhat approximating to what it is now. I am told it has been longer in use, but I could not give the details. The Manhattan Company has made many experiments. They have tried the iron process very extensively, and failed to succeed with it.

Q. That I do not want to go into. I confine myself to one class of questions at a time. Has not the ventilating process, as applicable to the additional purification of gas, been known to gas engineers for a long time? A. It has been known, but unfavorably.

Q. And no favorable process known until this was got out? A. Not that I have heard of. There have been dangerous accidents frequently from the attempts.

Q. Which of the processes now in use in this city, of manufacturing gas, is in your opinion the least offensive? A. I can have no hesitation in saying the process in use by the Manhattan Gas Light Company.

Q. Which is the next? A. I am not familiar with the process used by the Harlem Company.

Q. I confine myself to the Metropolitan, New York, and Manhattan. The Manhattan is the best, you have said. Now, which is the next, in the sense of being the least offensive? A. To whom?

Q. The least offensive in the process of manufacturing. This order expressly says, or it speaks of the process of manufacturing. It looks to that. A. I cannot answer the question. I have never made but two visits to the New York Gas Light Company when they were opening the purifiers, and I cannot speak from so little experience and observation.

Q. If you cannot speak as to that, how could you speak so in your pamphlet, and in your testimony as to the merits of these process—of the New York Gas Company's process? A. Simply because I observed the facts stated in the pamphlet—I observed an offensive smell.

Q But you did not observe sufficient to enable you to say whether that process was more offensive than the Metropolitan Gas Company's process. A. I will make an answer to this point—which I presume ought to be satisfactory:—that on the occasion on which I visited them for this special purpose, the New York Gas Light Company's works, and the Metropolitan Gas Light Company's works, that on these special occasions, I observed a worse smell at the Metropolitan Gas works than I did at the other, as far as smell is concerned.

Q. And all your knowledge as to the matters connected with the iron process, you derived from what knowledge you obtained at those two visits? A. I cannot say that.

Q. Have you had any opportunity of ascertaining the effect of the New York Company's process, than you have had as to the question of its offensiveness? A As has been remarked here before, there are many iron processes.

Q. I am talking of the New York Gas Company's iron process. Have you had any more opportunity? A. Not of that special modification; I have not.

Q. In changing from the lime process to the iron process, is anything more needed than only changing the purifiers, and removing the trays and putting in iron instead of lime. A. That is strictly a question for an engineer to decide. The difficulties met with would probably be more in the collateral and subsidiary arrangements or fixtures necessary, than in the mere cleaning out of the lime and putting in iron.

Q. What fixtures do you refer to? A. As I stated before, I am not specially familiar with the New York Gas Company's process. I have seen their material spread out on the floor of their purifying house and in the open air, but I cannot state how much space they require to spread it out.

Q. I am talking about the space they require for revivifying. Suppose they desired to change to the iron process; would they need anything more when the purifiers were changed, than to take out the trays and put in iron instead of lime? A. I should regard that merely as a question to be decided by reference as to the facts of what the New York Company did under the circumstances—the modifications of their machinery.

Q. Is that the fact, that that was all the change they made? A. I could not say whether the New York Company made any change in their fixtures.

Q. Then, anything you have said as to the impossibility of the Metropolitan Company's changing to the iron process, you do not know, as a fact, whether they can or can not, nor as to the time it would take. A. So far as the mere substitution of the iron for lime is concerned I could not.

Q. Accepting the fact that the iron can be substituted for the lime; what other thing is there involved in the change, which will take time. Is there anything more than a sufficient space for the revivification of the iron? A. In answering that question the most prominent point that comes to my mind is as to whether they would be able to command trained workmen, familiar with the iron process.

Q. Does it require any trained workmen? A. I should think it extremely probable it did. My experience is to the effect that no modification, in any great manufacturing operation, however small, can be carried on, however simple, without trained work men.

Q. Do you not know, as an actual fact, that at the New York Gas works, the men are not trained? A. In the peculiar process relative to the iron:—I do not speak of mere laborers, I mean the men who are relied upon to see to it—the responsible men who are competent to meet any unlooked for contingency. Q. Do you not know that the parties controlling the process in use at the New York Gas works have made an offer to furnish all the assistance necessary to introduce that process elsewhere? A. It may be so, but I have not encountered the information.

Q. Have you not seen their circular? A. I have not that I remember. I have not read it.

Q. Are not all the processes used in this city by the three large companies for the manufacture of gas unhealthy? A. I should regard the iron process as having a tendency to affect the public health injuriously.

Q. In what way? A. By leaving the sulphur in the gas.

Q. You mean by introducing it into the rooms? A. Yes, sir.

Q. Now, taking that iron process and applying lime to it subsequently, would it then remain unhealthy? A. Probably not, it would only affect the eyes of the public.

Q. The effect would be deleterious to the illuminating power of the gas, would it not? A. I should apprehend that it would.

Q. Then, if the companies were required to introduce that ventilating process of lime, after the iron, and were required to furnish for a given sum of money, the same illuminating powers, the only deleterious effect would be upon the stockholders, would it not? A. That is scarcely a question for a chemist.

Q. Unpleasant odors are not unavoidable in the practical manufacture of gas? A. It has been recently so discovered by the Manhattan Gas-Light Company.

Q. And that by the process which has been in use two or three years? A. Secretly; that is, it has not been a matter of publicity.

Q. Has there been any difficulty in any way, so far as you know of gaining access? A. Not so far as I know. I have found the doors open.

Q. Why did you say secretly? A. Secretly may be too strong a term. I mean, privately—it has not been a matter of publicity.

Q. Have all of the gas companies and yourself known all about it? A. I think not, from the fact that I have talked with officials of the gas companies, who, until quite recently, had not understood the nature of it.

Q. What officials do you refer to? A. That I do not think I should be called upon to say.

Q. Any officials of the Metropolitan Gas Company? A. No, sir. I could not specify any officials of the Metropolitan Company.

Q. Was or was there not any one of that Company? A. I do not remember any especial individual.

Q. When were you consulted by the Metropolitan Company with reference to any question connected with their manufacture of gas? A. I could not remember the precise date. The President of the Company called upon me first in connection with matter some time in August last, I believe.

Q. What then happened—was there anything more than asking you to suggest something? A. The salient points of that interview which recur to my memory are, that the President desired me to recommend to him some gentlemen who would be competent to take up the investigation of gas purification, with a view to the improvement of their process.

Q. At that time you knew the Manhattan gas process was in operation? A. At that time, yes, sir. Previous to that I had been examining it.

Q. You satisfied yourself it was successful? A. I was not so strongly decided about it as I became afterwards. I was making up my mind in that direction.

Q. After that time, when did you first do anything further in connection with the Metropolitan Gas Company's process? A. Not until within a few weeks. I was not called upon until a few weeks since. I cannot remember the precise date at this moment.

Q. Have you not a personal knowledge of the iron process in use abroad? A. I have not, sir, from observation.

Q. You do not know how the New York Company's process bears comparison with them? A. Not from observation—no, sir.

Q. You heard Professor Silliman's testimony? A. I was present at the whole of his testimony, I believe. I heard most of it—yes, sir.

Q. Is there any portion of it you disagree with? A. There may be some minor chemical points involved in which I did not agree with him. I have already alluded to one point—as to my estimation of the actual poisonous character of the sulphurous acid in small quantities.

Q. Is there anything else that occurs to you? A. There were other points which I really cannot recollect at this moment.

Q. Anything of any importance? A. Nothing of any essential importance bearing upon this question, that I recollect.

Q. You spoke of ozone in the atmosphere—is there any great quantity of ozone in the atmosphere of cities? A. It is very varying, as a general thing. It has been found in the atmosphere of cities constantly by tests applied.

Q Is not its amount very much less than in country atmosphere? A. Its amount is small, but it is believto be constantly present and constantly reproduced.

Q. Is it not much smaller than in the atmosphere of the country? A. I do not recall the facts distinctly enough at this moment. My impression is that it is so—that in cities it is usually smaller than in the coun-

try. That depends upon the proximity of the sea coast, I think.

Q. Do you consider yourself a sanitarian? A. Only so far as I have had my attention drawn a good deal in the course of my studies, and in my practice; though to subjects rather connected with therapeutical subjects than sanitary.

Q. How as to physiological matters? A. I could scarcely call myself a thorough physiologist—toxicology I have studied pretty thoroughly—the science of poisons.

Q. Is not anything injurious to health, in a greater or less degree, which changes the natural composition of the atmosphere we breathe? A. I do not know that I get the full sense of the question.

Q. Is not anything which changes the composition of the atmosphere which we breathe, dangerous to health in a greater or less degree? A. I should say the question was scarcely definite enough for me to answer, yes or no.

Q. Is the healthiest atmosphere that which nature has made? A. That is decidedly the dictate of experience.

Q. If any change of any kind is made in that, does it not in a greater or less degree make it unhealthy? A. The atmosphere itself is variable somewhat.

Q. Can you answer my question or can you not? A. It is simply a question as to the degree of the change, and the kind of change. There are many changes that could be made, which would not affect the health appreciably or at all. Most atmospheres might even be changed for the better, as regards health.

Q. Now, the Manhattan Company's process—what change would it require to introduce that at the Metropolitan works? A. That is, also, a question which the engineers would have to answer. I could say, generally, that additional buildings would be required; and I presume an additional exhauster, or engine of some kind, for producing a current of air through the purifiers.

Q. What additional buildings? A. An additional building for the supplementary purifier at least.

Q. Anything else? A. It would require an additional engine-house and room for the exhauster. This additional building for purifying is nothing more than a brick building—perhaps 20 feet square. That is a very small matter. The engine and boiler would be the main thing—the engine for drawing the air through.

Q. Is that a matter requiring any great time? A. I beliieve it generally takes some time to set the boilers and erect an engine, and get them in working order.

Q. It is simply the time necessary to set a moderate sized engine? A. I presume so, so far as I can say, not being an expert in that particular branch.

Q. You have spoken of over purification, and of the effect of absorption af naphthaline—what is the effect of it—anything but to reduce the illuminating power. Is it anything ‹ther than that? A. I don't know that it produces any other injurious effects.

Q. I understand you to say that in your opinion, the New York Gas Company's process allows too much sulphur to pass into the rooms? A. That would seem to be the conclusion, not only from general experience in the iron process, but also from Professor Chandler's direct investigation.

Q. You state in your pamphlet that "the Metropolitan Gas Companies have consequently been unable to comply with the conditions required by the Metropolis Gas Act of 1860, that the gas shall not contain more than twenty grains of sulphur in 100 cubic feet." Speaking of the London compantes, you consider the parliamentary requirement, reducing the sulphur to 20 grains in 100 cubic feet, as reducing it to the point of health? A. I consider gas containing 20 grains of sulphur as still decidedly objectionable, if better can be done.

Q. Then you consider that the parliamentary limit of 20 grains to which the London companies have been enabled to reduce it, as still leaving it unhealthy? A. Under circumstances favorable to the development of its detrimental effects, I should.

Q. Schultz is a competent chemist, is he not? A. In gas matters he is a very good chemist.

Q. Then when he states that the New York Company's iron process has reduced it to 12 91 grains of sulphur in 100 cubic feet of gas, you admit that is about one half less than the English parliamentary limit? A. I should not attach much importance one way or another to those figures given there, as to the quantity of sulphur. They are both in my opinion lower than is probably the truth—considerably lower.

Q. Then why do you say in your pamphlet, "the most striking fact developed by the above short but significant report, is the high degree of freedom from sulphur of the gas of the Manhattan Company," if you did not believe it to be true? A. I spoke there of the report.

Q. Why did you, in a report to the company quote another report which you did not believe to be true, and state "that that was exceedingly significant and satisfactory"? A. It would be rather strong language to say that I do not believe the report to be true. I believe it to have been low in all probability—the word believe, is too strong a word to use in the connection, in my opinion.

Q. Do you believe that this report of Mr. Schultz is correct? A. I think in the main it is.

Q. Do you believe it to be correct in its statement, of the sulphur in the gas of the New York and Manhattan Companies? A. I have no belief on the subject. I think it is not strictly correct.

Q. How long have you so thought? A. One important piece of information, which led to the modification of my opinion, upon that subject, was Professor Chandler's investigation.

Q. How long have you so thought it was not correct? A. Since I have myself been occupied with Professor Silliman, within two months past, in some determinations of the sulphur in gas, which have led me to believe that some determinations of the sulphur, heretofore made, have been too low.

Q. Then I understand you that you consider this report of Mr. Schultz, so far as it relates to the amount of sulphur as valueless? A. The results of Mr. Schultz and Dr. Torry were doubtless obtained by the method which has been in ordinary use by gas companies for determining the sulphur, and which was introduced by Dr. Letheby. Several other chemists have recently come forward with the opinion, within the last year, that all the determinations made by Dr. Letheby's apparatus are too low, and that the amount of sulphur is much higher than has been placed by him, showing that the amount of sulphur as indicated by Dr. Letheby's method is incorrect.

Q. It is the method which has been used in England for determining whether the companies there have conformed to the parliamentary standard? A. Yes, sir, and it is very seldom that it has given 20 grains, until quite recently.

Q. If by a process which is used abroad to determine whether the gas comes up to the parliamentary standard, it is found that the oxide of iron process gives eight grains less of sulphur than the parliamentary standard requires, does it not show that that process is superior to the process in use in London? A. A great deal depends upon the coal that is used in making the gas. If very pure coal is used, free from sulphur, applying the same process of test abroad and here, we get eight grains less in the New York Company's process than is required by the parliamentary standard—between seven and eight grains.

Q. Taking that same test, does that not show, that the iron process in use by the New York Company is, so far as sulphur is concerned, superior to the process in use abroad? A. It would simply show, to my mind, that it is probable that just at that particular time, the New York Gas Light Company were operating in some way; either by the aid of coal favorable to such a result, or by that combined with other means, of scrubbing for instance, which they use, as I am told, so as to produce a gas very free from sulphur. I do not know that the oxide of iron process—I do not know that it would be right to attribute the whole result to that.

Q. Here is a test that is used abroad, which gives between seven and eight grains of sulphur less to 100 cubic feet, than the parliamentary standard requires. Now, it being stated by yourself that the companies in London cannot even come down to the parliamentary standard, does not that fact show that the process of the New York Gas Company furnishes a gas purer and more free from sulphur than that of the London companies? A. Speaking of the whole process of the New York Gas Light Company I should answer in the affirmative.

Q. I understand you to agree with Prof. Silliman in saying this; in so far as purposes of health are concerned, the question of napthaline and phenol may be left out of this consideration? A. I consider them very minor matters.

Q. Do they have any bearing whatever other than the fact that phenol is a disinfectant? A. I should prefer to throw them out of this consideration. I think they bear about as much upon the one side as the other, in every aspect, both *pro* and *con*.

Q. Is not sulphide of ammonium found in gas purified by the Manhattan process? A. I have not recently tested the gas of the Manhattan Company. So far as my own knowledge extends, they do not deliver gas containing delectable sulphur.

Q. Was not the sulphide of ammonium found in the purified air, on being delivered from the supplementary purifier? A. It was, but in a very minute quantity. It was scarcely perceptible to the smell, though it was to lead paper.

Q. You have used in your direct testimony, at various times, the words, "There is no evidence, that so and so occurs in or is accomplished by the iron process." What do you mean by that. Do you mean that you have not investigated it sufficiently to say that these things are accomplished, or what do you mean? A. There is more than one case of the kind, to which different answers would apply. There are cases in which, if I remember aright, I made use of that remark, in which the matter has been investigated.

Q. The expression is peculiar, "There is no evidence." A. I mean that we cannot proceed in chemical matters any more than in legal matters, without some evidence—without facts to start from.

Q. When you say that there is no evidence, that such and such things are eliminated by the iron process, do you mean that does not eliminate, or simply that you do not know that it is eliminated? A. I simply mean that no chemist has ever brought forward any evidence, from experiments, that it has been eliminated.

Q. Do you mean that no chemist has ever brought forward any evidence, that it has not been eliminated? A. In some cases I do. In the case, for instance, of the bisulphide of carbon, some chemists have made very extensive experiments with bisulphide of carbon. They found compounds of bisulphide of carbon with lime, but they found none with oxide of iron that I conld find any evidence of.

Q. Do you know whether they looked for any? A. No, sir; I cannot say that.

Q. Did they say that they found none, or simply failed to mention them? A. If they had found them they would have mentioned them.

Q. Do all gas companies apply the scrubbing process. Is it in use by all companies? A. No, sir; not by all.

Q. Is it in use by all the companies in this city? A. I think the Manhattan Gas Light Company do not scrub their gas before condensing it.

Q. In speaking of the hydrosulphuric acid and hydrosulphate of ammonia in your pamphlet, you say, that "in the lime process the conditions present themselves merely for the arrest of all the free carbonic and hydrosulphuric acids, and free ammonia salts, in definite forms of combination. In the case of the iron process this can by no means be asserted."

Q. Do you mean to say, by that, it is not true of the iron process? A. No, sir; I mean that the weight of evidence is very much against it in the case of the iron process—the testimony of facts and investigations, so far as they have gone.

Q. In speaking under the head of carbolic and cresylic alcohols at its close, you refer to the advantage of the lime, and then say, "which, however beneficial under peculiar circumstances, cannot be regarded as, by any means, indispensable and desirable as a compulsory infliction upon consumers of gas." What do you mean by "peculiar circumstances?" A. I mean in case there are bad smells or an infectious atmosphere. Carbolic acid or phenol might then be even beneficial, but that under ordinary circumstances the delivery of gas containing creosote and like substances would be objected to in private houses. I should class phenol—however, I believe we have concluded that phenol is a matter of such minor importance, that it might as well be thrown out of consideration.

Q. On page 13, you make a quotation from the last edition of Clegg, and then one from Bowditch, and say that you are inclined to agree with Mr. Bowditch. I understand that to be your present view? A. The first paragraph, although taken from the edition of 1866, is very likely a copy taken from the previous edition.

Q. Then, I understand the view you there express to he the views you now entertain? A. Do you refer to the passage commencing, "I am constr ined?"

Q. Yes, sir. A. I still have that opinion.

Q. If you are of the opinion that there is still a worse smell at the Metropolitan Company's works, when they change their purifiers, than at the New York Company's process, what opinion do you entertain then of the Metropolitan Company's process? A. I stated at the very outset of my examination, I am confident, if my recollection serves me, that there was a bad smell given out by the Metropolitan works.

Q. The point is here. You make a quotation, in which you say, "The vapors of the hydrocarbons are much heavier than the atmosphere, and when evolved from the foul oxide of iron by the heat of chemical action, they float in the lower stratum of the atmosphere, near the surface of the earth, and produce extensive nuisances. There are few smells more offensive to many persons than the smell of these compounds given off by the oxide in the process of revivification, and in every gas works. They ought to be consumed instead of being allowed to escape. If this be not done voluntarily, the law ought to compel it." Then you say, "I am constrained to state that my own observation, so far as the natural capacities of my mind and senses extend, bears out the positive assertions of the Rev. Mr. Bowditch in the latter paragraph." Having stated that, and having stated further here, that the smell from the Metropolitan Gas Company's works is more than that from the New York, what, in your opinion, should be done with the smells given off by the Metropolitan Company's works? He said they ought to be burnt up in the other case? A. They should most certainly be prevented by the best means which offer to accomplish that result, because they are unpleasant to the public. I should state, however—I certainly ought to be allowed to recall—that when I stated there was a worse smell at the Metropolitan

Company's, I spoke of the works, and not of the neighborhood, at a greater or less distance from the works; because I should say precisely the opposite with regard to that. At a little distance from the New York works, I perceived a bad smell, and across the street from the Metropolitan works I perceived a very slight smell.

Q. Do I understand you to say that the smell from the Metropolitan Company's works is not perceptible at a distance from the works? A. I have not succeeded in perceiving it at a distance of about one block from the works—I mean the offensive stench. I have not happened, it may be a mere accident, to catch the very offensive stench which has been spoken of.

Q. You say on page 15, "as regards the peculiar unknown substance which diffuses itself from the purifiers when opened." To what purifiers do you refer? A. I was then speaking generally of the ordinary dry lime process of purification, without any assistance from other devices.

Q. You are still of the opinion that that odor has a resemblance to, or belongs to the class of sickening odors, and is developed and intensified by aerial dilution? A. I have perceived such odors

Q. Are you still of the opinion expressed in that passage? In connection with my last reply I am.

Q. How do you account for the fact that it is intensified by atmospheric or aerial dilution? How do you account for the fact that you smell it at the works and do not smell it across the street? A. I did not smell it at the Metropolitan Gas Works, as I have said in my direct evidence. I have tried to catch some of it in a shawl and could not get any of it.

Q. You smelled some of that class of smells? A. No, sir. The smell at the Metropolitan Gas Works was a different smell from that referred to. I did not perceive any of this smell at the Metropolitan Gas Works at the time I visited it.

Q. Then you did not smell, at the Metropolitan Gas Works, the peculiar unknown substance which diffuses itself from the fouled purifiers when opened? A. Certainly not so much as I have perceived for example about a building, the roof of which was having coal tar put upon it.

Q. Then if you did not perceive the peculiar odors which came from fouled purifiers, to what odors did you refer when speaking of the smell as being offensive? A. In the Metropolitan Gas Works?

Q. Yes, sir. A. I referred to the smell of sulphide of ammonium, which was perceptible in the purifying house, and to a certain distance around it.

Q. Did you perceive any other offensive smell than that of sulphide of ammonium? A. I perceived the smell of naphthaline, which is rather pleasant to me.

Q. Did you perceive any offensive odor from the purifiers? A. I have already stated that I perceived an odor which was usually classed as offensive.

Q. But it was not the odor you referred to on page 15? A. I did not recognize it as such. I attempted to account for that in my direct evidence by attributing it to the scrubbing of the gas—the copious quantity of cool water which has taken off all these offensive materials, in all probability, to the tar well.

Q. Have you ever heard of the oxide of iron process catching fire? A. It is spoken of frequently in books. I have not had it under my personal observation.

Q. Do the books say that it has caught fire, or that there is danger of it? A. They say that it has caught fire, I believe.

Q. At this time that you went to the Metropolitan Gas Company and did not perceive these odors from the purifiers—was your arrival there expected, were you there by appointment? A. On my first visit, when the purifier was opened, it was expected; but I am not aware whether it was or not on the visit which I made with Professor Silliman. I do not think it was expected, certainly the time was not set.

Q. What is your opinion as to the proper future of the Metropolitan Gas Company as to its process of manufacturing? A. It was answered in great detail by me, to the best of my recollection, in my direct testimony. I gave my opinion as an expert that the Metropolitan Gas Company should be guided by the past experience of other companies—by the past history of this controversy, as it has taken place already.

Q. Is it not your opinion that they ought to put the process in use which is used at the Manhattan Company's works? A. I do not feel as if it were a proper question to ask me on this occasion. I have no objection to reply to it, if it is insisted upon. I do not look upon myself as called upon here as an expert to advise the engineers of the Metropolitan Company as to their duty.

Q. You are here as an expert. I will put it another way. Is it your opinion that, out of consideration to the public convenience—leaving health out of the way—a gas company having its works situated as the Metropolitan Company's are, should introduce the Manhattan Company's process? A. So far as my knowledge of gas purification extends, I should think, if I am required to give an answer to that question, I should answer in the affirmative.

Q. Aside from all theoretical considerations, is it not a fact that the gas companies in nearly all the large cities in Europe have been compelled by the sanitary authorities to so modify their process of manufacturing as to prevent the dissemination of the offensive gases which are still liberated by the Metropolitan Company from their fouled lime? A. My general reading of gas literature permits me to answer that in large cities and densely-populated neighborhoods they have.

Q. In other words, your answer is in the affirmative? A. It is in the affirmative, I believe, if I understand the question distinctly.

Q. Is the *American Gas-Light Journal* a recognized authority? A. It is the only authority in the shape of a journal in this country upon gas matters.

Q. In the number for February 16th, 1869, the article under the heading of the "War of the Purifications," when did you first see that article? A. Is it necessary to be very precise about the time; I don't know that I can recollect it aright.

Q. Give it as precisely as you can? A. I think I saw it there on Wednesday or Thursday last.

Q. After its publication? A. That question I shall decline to answer; I do not think I am called upon to give the authorship of an article in a paper; it is attributed to the editor of the paper.

Q. Did you write the article? A. (*By advice of Judge Van Vorst.*) I wrote the article.

Q. Does it express your opinion? A. Well, so far as any opinion is expressed in it, it does.

Q. Does it state correctly your position? A. Not my individual position; it states the position of the Journal.

Q. But it does not state your individual position? A. I did not feel called upon then, nor do I feel called upon now, to state my individual position in the case.

Re-direct examination by *Judge Van Vorst:*

Q. Do I understand you to say, in answer to the question of Col. Bliss, that in your opinion the Metropolitan Gas Company would do well to adopt the process of ventilation in use by the Manhattan Company? A. It would, in my opinion, be well for them to thoroughly examine into the process used by the Manhattan Company, and adopt it in some form of modification. I do not look upon it as a perfect thing by any means yet. No process is perfect; they might be able to improve upon it.

By *Mr. Bliss:*

Q. It is the most perfect you know of, is it not? A. It is, as I said in my examination.

Adjourned to Wednesday, February 24th, at one o'clock.

SATURDAY, February 27th, 1869.

Oscar Zollicoffer, called for the Metropolitan Gas-Light Company, being duly sworn, testifies as follows. Examined by Judge Van Vorst:

Q. You are the President of the Metropolitan Gas-Light Company? A. Yes, sir.

Q. How long has that Company been in operation? A. Five and a half years.

Q. What district do you light? A. From 34th to 79th streets, between North and East rivers.

Q. You used the lime process for the purification of gas? A. Yes, sir; at present dry lime.

Q. Was that process in use throughout the city when your Company went into operation? A. There was none other than that; it is only lately that we knew of another process.

Q. What, if any, preparations or efforts have your Company made to remove the effete lime after it has purified the gas—state what you have recently done on that subject? A. I have engaged boats, as I promised Dr. Chandler six months ago; when the material is placed on the boats the hatches are closed without any delay and then it is removed over to New Jersey, where have engaged dumping-grounds.

Q. That is to say, as soon as the purifiers are opened the lime is removed to those boats lying at your dock? A. Yes, sir.

Q. And the hatches are closed on the lime immediately? A. Yes, sir.

Q. And that you mean to continue? A. Yes, sir, until another method is found out for purification.

Q. Has your Company any preference for the dry lime process of purification, if there is a better process than that? A. Not in the least; I told Dr. Chandler that very thing; we want the very best, whether it is lime or oxide of iron; we want that which is the best for the purification of the gas, and at the same time which will retain its illuminating power.

Q. The object of the Company is to obtain the best gas and also to have the best illuminating power? A. Yes, sir, we would like to improve upon any method.

Q. Since this proceeding has been pending before the Board of Health, what have you done about ascertaining the process of purificatton in use in Europe? A. We sent ont a special man that was recommended to us very highly from two well known chemists, to ascertain the different modes of purification in use there; he has just returned.

Q. What did you send him to Europe for? A. To ascertain the modes in use in England, in France, in Germany, to see what improvements could be made and with the intention to immediately adopt that which from the different reports he should make should be the best, after its being submitted to the Board of Health, if acceptable to them; I proposed to Dr. Chandler, as soon as it is in operation that he shall come and see it on the premises; if it had not been for the press of business, we could have had it in operation by the first of March; the spent lime is all going to be removed; it is now being removed, a large quantity being taken each day; there is no smell to that lime.

Q. You are having that removed all the time? A. Yes, sir; we want the room ourselves.

Q. You say that your time is engrossed in extending your works? A. Yes, sir, in extending our works and making improvements and repairs we occasionally need very much this year.

Q. Has there been any special pressure on your Company this year? A. Yes, sir, particularly so; from the increase of the consumption of gas in the district; we must build more retorts and gas holders this year.

Q. Your works have been tested to their utmost capacity. A. Yes, sir, to the utmost in December and January; to the utmost they could produce.

Q. What, if any steps, has the Company taken lately for the purpose of introducing any improved method for the purification of your gas? A. As I said before, we engaged a chemist and sent him to Europe.

Q. Has your Board appointed a committee to introduce an improvement immediately. A. They have; they made me chairman and appointed three members to take it particularly in charge.

Q. With instructions to introduce immediately some improved system of purification? A. Yes, sir.

Q. So as to avoid all offensiveness? A. Particularly to avoid all bad smell; I forgot to say we had a chemist who has been making experiments, and has several times destroyed the bad smell in small quantities of the effete lime, and he believes he can do it on a large scale.

Q. That is remove the foul odors from the spent lime? A. Yes, sir.

☞ *For continuation see Supplement.*

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[NOTE BY PROFESSOR WURTZ.—Contributions and items for which I am, as a Scientist, individually responsible, will have attached my full name or initials.—H. W.]

TUESDAY, MARCH 16, 1869.

WISHING TO MAKE this Journal an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of those subjects a pleasure, or a profession.

Subscribers would confer a favor upon us by remitting *CHECKS* or *POST OFFICE MONEY ORDERS*, as we are frequent losers where money is enclosed in letters.

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NOTICE.

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Answers to Correspondents.

P. J., of Pa.—Bowditch's clay patent for purifying gas was claimed by its inventor to entirely remove the bisulphide of carbon, but we believe it is not efficacious for this purpose. Some of the ablest gas chemists in England experimented with it, and pronounced it worthless.

B. W. S., of Mass.—The Canada oil is considered as rather superior to the Pennsylvania oils. It has more body and on distillation yields a less amount of light hydrocarbons.

C. J., of Pa.—The gas-holder at the works at Point Breeze, Philadelphia, is the largest one in this country. We believe there is but one larger in the world.

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GAS CHEMISTRY.

It is fully apparent to men of science, fast being recognized by the general public, and will soon be discovered by our gas companies (in the language of Dogberry: "it is known already, and will soon come to be thought so") that there must be an infusion of chemical science into the affairs of these great chemical manufacturing companies. To speak with the distinctness and emphasis which we believe to be demanded from us by the logic of passing events, we intend to be understood as implying that these great and rapidly growing interests have hitherto been chiefly under the control of men who are, as a class, empirical in character. In the conduct of this Journal, we desire further to be understood, that we prefer to follow the lead of *Science*, in its rules, always infallible in the end, of induction and of deduction from exact facts. "Practical men," so called, may sometimes be ahead of exact science, though far oftener behind; but usually, from our experience, in the wrong place; and the vast majority of the failures, expenses, and delays which are incident to the undertakings of mankind are due to their influence. Science copes with them under the two great disadvantages that its representatives are not only vastly in the minority, but notoriously inferior to their antagonists in the practice, usually in the power, of *self-assertion*; an influence so all powerful in this community.

When, however, such a crisis arrives as that which is now preparing; when disputes and misunderstandings, involving such a multitude of points only to be tested and determined by the exact instruments and methods of Science, in the hands of those most highly skilled in their manipulation and use, and which are only being constantly enveloped, by the rude operations and inexact methods of the "practical men," in greater and greater obscurity; and when by the rapidly increasing magnitude of the interests involved, the whole subject has reached its present vast importance, it is plain that the *chemists* must at last be called in. They must at last be authorized to do their utmost to investigate the whole subject, and apply such chemical rules and principles as will so improve the manufacture of illuminating gas, and so regulate its supply to consumers, that the latter may obtain some assurance, both as to quantity and quality. It is an almost incredible fact that many of our largest gas companies make no pretence of having a chamical adviser at all.

The occasion which suggests these brief remarks, introductory only in their scope, is furnished by the testimony we have now so completely laid before our readers, of the Chemical Experts called in the case of the proceeding of the Board of Health against the Metropolitan Gas-Light Company. The concluding reports of this case has been so late in reaching us, and are so voluminous, that no general review can now be presented. We shall only remark thas it will become clear to any reader of this testimony that many most fundamental and essential chemical principles, bearing upon the manufacture and purification of gas, of the best quality attainable from given materials, as yet remain in a most unsatisfactory and unsettled condition; and, considering even the best interests of the Gas Companies themselves, call loudly for the immediate application of a great and elaborate amount of the most competent and scientific investigation and analysis.

We shall sum up, as our most obvious and important deduction from this mass of testimony; that the only course, on the part of the companies, which is likely to be satisfactory to the public, is an immediate junction of their forces and an exercise of every practicable degree of diligence in employing the highest order of real and *tried* scientific skill and labor in arriving at precision as to all these mooted points. Should the companies fail to take such measures as these, and (with a few very honorable exceptions) persist in their present slip-shod policy, without unity of action and purpose, and repudiate the above reasonable, seasonable and common-sense method of meeting the demands that the public seem just now to be urging, for progress and improvement in the production of this great necessary of life; the result is not difficult to foresee. The public will doubtless take the matter into its own hands, and by legislative action enforce the performance of these duties by the companies, and it might be, in ways not so acceptable to them as those they would themselves select and adopt.—H. W.

THE GAS COMPANIES AND THE LEGISLATIVE COMMITTEE.

A Legislative Gas Committee are in session at the St. Nicholas Hotel, New York, and havn been also in Brooklyn, investigating the concerns of the gas companies, and the manufacture of gas, etc.

This committee are here in pursuance of a resolution of the Assembly, adopted February 15, 1869, of which the following is a copy:

On motion of Mr. P. Mitchell,

Resolved, That a committee, consisting of seven members of this honorable body, be appointed to make inquiry of and concerning the gas companies in the city and county of New York, the city of Buffalo and the city of Brooklyn, as follows, viz.:

1. Have such gas companies, or any of them, since their organization, made any returns of income, profits, or dividends; if so to what state officer have said returns been made, and the various amounts of the same?

2. Is the gas supplied by said companies to the people of said cities of such quality as to demand the price now charged for the same by the said companies?

3. Can the people of said cities for a more reasonable price than that now charged by said companies, be supplied with a superior quality of gas?

Resolved, That said committee have full power to send for persons and documents necessary to facilitate their investigations, and that said committee, without delay, report to this honorable body the result of their said investigations.

Ordered, That Messrs. P. Mitchell, La Bau, Bender, Hodges, Baker, Weed and Bergen be such committee.

We do not propose at present to speak of the necessity or propriety of the action taken in this matter by our worthy Legislators at Albany. It is to be presumed, of course, that the objects of the investigations are laudable and for the public benefit. The information sought for in this investigation is divided into three separate and distinct parts, as will be seen by referring to the resolution.

Now, after all the information upon these points has been exhausted, we would suggest the addition of another and fourth clause to the Legislative resolution.

To wit, 4. *Can the people of said cities be so instructed that they can use gas so as to get the full benefits thereof, in order to get the full equivalent of illumination, and not lose from* 20 *to* 80 *per cent from pure ignorance of the laws, which under different circumstances govern the combustion of gas.*

It is a fact we do not hesitate to state, and which we can easily prove, that more than four-fifths of the consumers of gas, do not know the first conditions to be observed in order to get the full amount of light capable of being eliminated from the gas they pay for. It is also a fact that half of those who do have some idea of the subject, neglect to employ proper means to secure the best results. Hence it is we hear complaints about gas monopolies and outrageous gas bills, when in truth the fault is mostly owing to the want of a little information and a little care. No other article of general use and necessity in domestic economy is so recklessly wasted and lost. If a barrel of flour comes into your house and your cook burns it up in the oven, and wastes it in various ways you do not complain to the manufacturer or the seller of the flour, because your bread is poor, and your flour bills for the month or quarter are high. Nor yet do you condemn the meat as being bad, and berate the butcher, because the cook burned it to a cinder, and you had only half a dinner therefor. But you burn up your gas with 20 to 80 per cent. more air than is required for full illumination, or waste it in loose joints and leaky fittings, or refuse to apply a pressure guage or regulator, or neglect to employ burners best adapted to burn the gas economically, or persist in hiding the light in semi-transparent, translucent and almost opaque globes and shades, etc., and then lay it all to the gas companies, because your light forsooth is poor and your gas bills high.

We have frequently published articles of *information to the people* on the subject of using gas economically, and shall in our next number commence a series of articles on this subject, which will tend to educate the consumers of gas so they may save themselves much annoyance and much money, and at the same time remove from the public mind the false prejudice which now seems to exist so greatly against gas manufacturers.

GAS COAL.

Our attention has been called to a debate that recently took place in Congress on the price of gas. Some of the statements made were so far from being correct, that we think it a duty to point out wherein several members of the House were in error. One member stated "that Cumberland coal *was a gas coal*, and that some of the best gas coal in the country comes from the Cumberland mines, and that it could be delivered in Washington for less than $5 per ton, etc."

Now, as Cumberland coal *is not a gas coal*, and not one pound of it is used in gas works, the price of it is of little consequence. The coals used by gas companies on the seaboard comes from *west* of the Alleghany Mountains, the British Provinces, or from England. East of the Mountains the coal is semi-bituminous, like the Cumberland: broad top or anthracite like the Schuylkill and Lehigh.

The gas company at Washington probably obtain nine-tenths of their coal from West Virginia, or Western Pennsylvania, and one-tenth from England. The former comes from 300 to 350 miles by railroad to Baltimore or Philadelphia, and is then sent by vessel to Washington; the latter comes 3000 miles to New York and is then transhipped to Washington. Last year the former coal must have cost them per ton at their works $8.50, and the latter $14; and if our supposition as to the proportions of the two kinds used be correct, the cost of coal to the company was $6.05 per ton, and not $5 as the honorable member stated.

When it is once fully understood that all coals *are not gas coals*, and that excepting Baltimore and Philadelphia, all other towns and cities on the seaboard must obtain their gas coal by transhipment, such statements as were made in Congress will not be repeated.

The same honorable member. in the discussion to which we have alluded, stated that the price of gas in Philadelphia, New York, and Boston was only $2.50 per 1000 feet. In this city the price is $3.50, and if any consumer in the other places named has a bill sent them at $2.50 we should like to see it.

THE GAS QUESTION.—We shall give an abstract of the testimony taken before the Gas Investigating Committee, in our next issue. The present issue with supplement closes the very voluminous and exhaustive testimony taken before the Board of Health, in regard to the "Gas Purification" question, and we trust our readers will excuse the exclusion of other matter in the last three numbers, which has been in order to make room for this interesting subject.

Several communications are received, but for the reason stated above, have to lay over for our next issue.

☞ We desire to call the attention of gas companies to the advertisement on page 281, signed "S.," and can say we are able to recommend the advertiser fully. The father of the young man is a very experienced and well known Gas Engineer, and will give his assistance as Consulting Engineer to the gas company who employs his son, free of charge, which is a desideratum not to be forgoiten.

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Make Valves ¼-inch to 24 inch, for Water, Steam & Gas.

FIG. 1.

Fig. 1 shows a single gate valve.

Fig. 2 represents wedge and one-half of

Fig. 3, a section through body, gate and wedge, intended for larger sizes of

The slides, G G, are held against wedge D, by ribs, H H, projecting from sides of valve body, A.

In closing the valves, when opening I is covered, slides, G G, pass the lower ends of ribs, H H, when the wedge, D, can move forward on the inclined planes E E, and crowd the gates apart.

water valves required to bear heavy pressure either side.

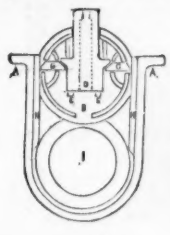

FIG. 2.

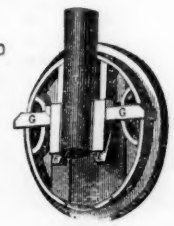

FIG. 3.

[From A. F. Havens, Engineer Brooklyn Gas-Light Co.]

"I take great pleasure in saying that they give perfect satisfaction—opening easily and quickly, and requiring no effort to start them, even after they have been closed months.'

[From R. E. Roberts, Secretary Detroit Water Works.]

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☞ More than 80 Gas and Water Companies have them. Send for Descriptive Circular.

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The right to manufacture, or State rights, for sale on reasonable terms. Address Editor AMERICAN GAS-LIGHT JOURNAL, No. 22 PINE ST., NEW YORK. 221-tf

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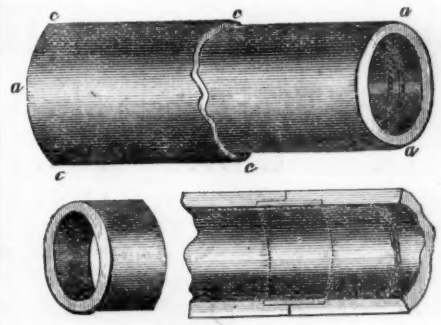

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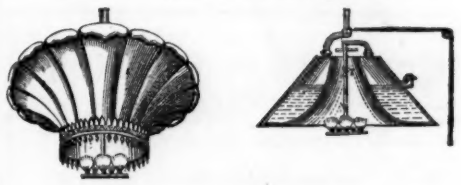

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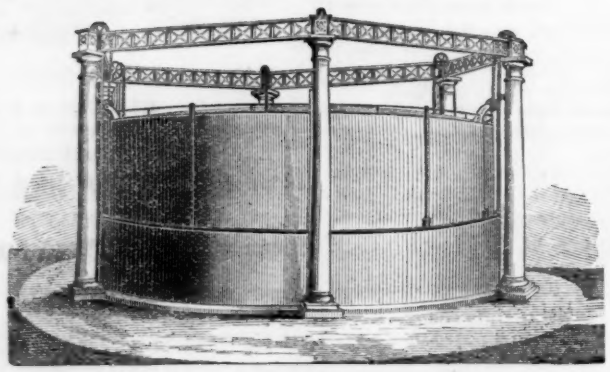

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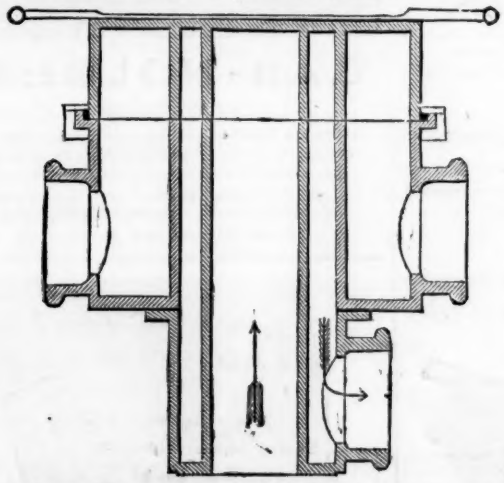

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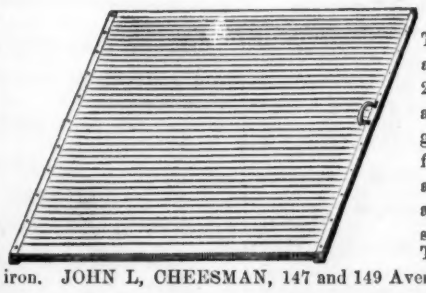

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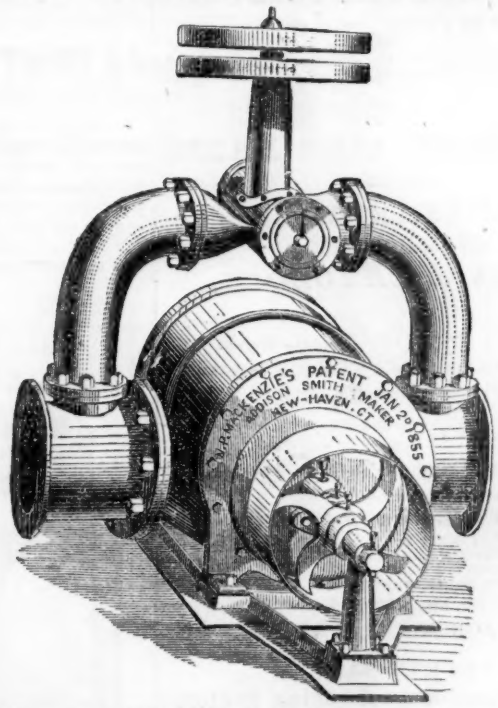

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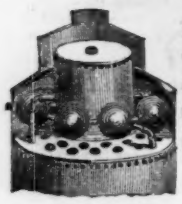

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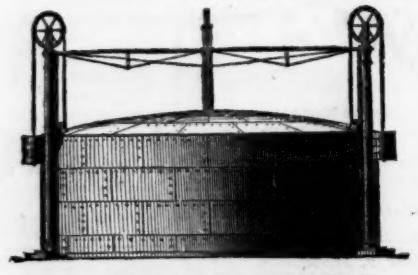

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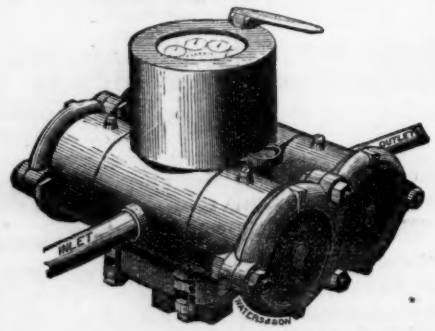

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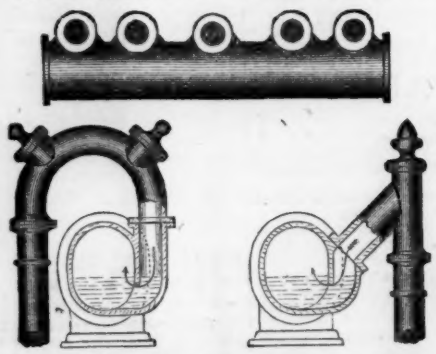

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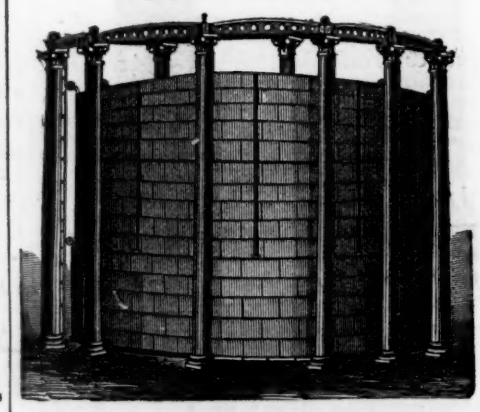

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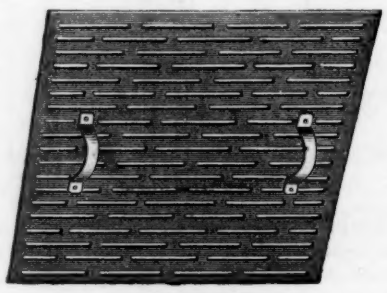

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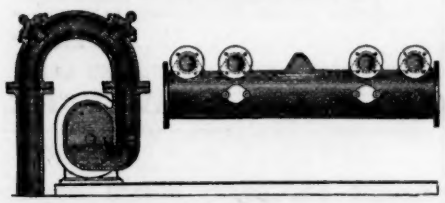

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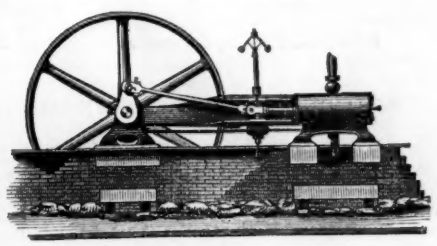

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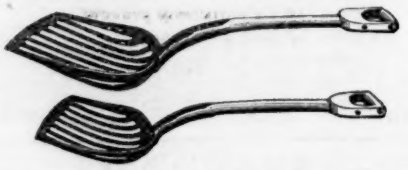

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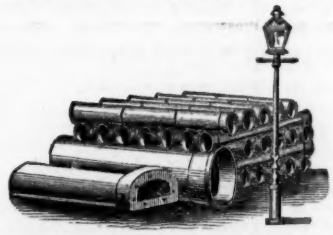

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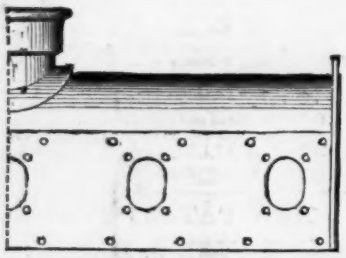

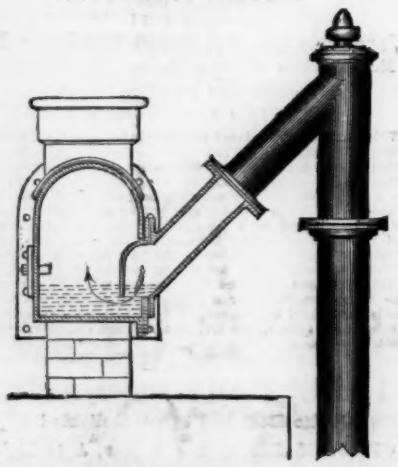

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[APR. 8, 1869.]

SUPPLEMENT
TO THE AMERICAN
GAS-LIGHT JOURNAL

NEW YORK, TUESDAY, MARCH 16, 1869.

[*Continued from page* 279.]

Q. And you think those experiments you will be able to report on on Monday? A. We will begin to work by it on a large scale, we think, on Monday and every day next week; the lime will be put into the liquid to destroy this smell; it is an experiment only, and I can't say it is perfect only on a small scale; next week all the spent lime is to be treated according to this new process.

Q. Which is the result of some recent experiments of this chemist you have spoken of? A. It is a wonderful success on a small scale; the sulphur is taken out and is crystallized.

Q. Is your Company in good faith now engaged in the work of so purifying the gas as to get rid of all offensive odors? A. Yes, sir.

Q. Col. Hastings is under the impression that you are pursuing the Fabian policy? A. No, sir.

Q. Your Board has no preference for your present system of purification over any better system? A. No, sir; on the contrary, I prefer the other one; I heard of it in Europe, and I told our engineers repeatedly that it was my view and I am certainly in favor of it.

Q. You would be glad if the process of purification by oxide of iron should prove to be a good process, and if so, your Company would have no objection to adopting it? A. No, sir, they would not have any objection.

Q. What should you think of adding a little lime to the oxide of iron purification? A. That is my impression; I am not competent to speak upon that subject, but I think it will be adopted again in English works.

Q. You think they will supplement the iron process with the lime? A. Yes, sir, with one larger.

Q. Would you think that would have any effect upon the candle power of the gas? A. Chemists say so and our engineer; we have got a chemist who has discovered what I think will no doubt be an improvement; I can't give the name as it might interfere with our arrangements

Q. Have you ever seen this process which is in use by the Manhattan Company? A. Yes, sir; it is just the same as ours; I have seen the retort—exhauster—where it passes through; Dr. Chandler told me he was not satisfied with that, that it was only carrying it from one place to another.

Cross-examined by *Col. Hastings:*

Q. Is there any other company in the city that is using the dry lime process in the same manner as it is used by the Metropolitan Company? A. I think the Manhattan has recently adopted theirs—the ventilation

Q. Do you not regard the process as used by your Company as the most offensive of any now in use in this city? A. Allow me to say, that I cannot say anything of that kind; the odors arising from our gas-works in our neighborhood are not offensive; we have four blocks round from which no complaints have come; Dr. Stone told me that in two years only two complaints had been made.

Q. During the process of the purification of the effete lime at the Metropolitan Works, is not a strong and pervading stench produced? A. Immediately when you open the purifier, but not longer than for half an hour afterwards.

Q. Does not that stench extend a great distance from the works? A. Not 2 blocks; we are different from the Manhattan, Company in that they do a large business, while we do a comparatively small business; I would like to have gentlemen come and see our works.

Q. Do you mean to say that the odors from this effete lime do not extend beyond two blocks? Except perhaps in very damp weather, for a day or two.

Q. How long have you known of the improvement now in use at the Manhattan Gas-Works? A. I should think about 18 months.

Q. Do you know any reason why your Company could not adopt a similar improvement? A. Because we do not think it is sufficient.

Q. Do you know any reason why your company could not adopt the same improvements? A. I think it is not quite sufficient. I don't think it would be satisfactory to the Board of Health.

Q. Do you know any reason aside from that why your company might not adopt it? A. Except that we are very crowded for room. It is a sliding ground there, and it is very difficult to make a high tower.

Q. Your company could obtain the room for that purpose? A. Far off; not near by.

Q. Do you know any reason why your company could not adopt the method of purification in use at the New York works? A. That, is because it has not been proved a success. Mr. Adams, the President of the Company, told me about three or four months ago, when I was there in August. He said, "Mr. Zollicoffer, do not adopt it. Every day the gas changes; one day it is good and one day it is poor. The gas is not uniform." You can examine him and he will tell you the same.

Q. When was this committee for introducing a change appointed? A. That was only at the last meeting—Wednesday of last week.

Q. Were they invested with full powers? A. Yes, sir.

Q. With full powers to make the improvements? A. Yes, sir.

Q. This is the first decided step taken by your company for the introduction of a change? A. No, sir; we have given you already what has been passed by the Board.

Q. But no committee was appointed? A. No, sir; it was left with the President and officers of the company at that time.

Q. And beyond sending an agent to Europe and the recent experiments you have spoken of, nothing has taken place with reference to a change since this investigation commenced? A. Have been all the time reading and studying.

Q. No other experiments? A. No; we hadn't the time to spare.

Q. When was this chemist employed to report on a better process? A. In was in September or October when he went to Europe.

Q. What is his name? A. Schussler; he resides in this city.

Q. You say that the process recommended by him is to be introduced at the works? A. No sir; that is another one.

Q. When was the chemist employed who is about to recommend a new process to your company? A. It is about three weeks ago first.

Q. Who is he? A. Mr. Milachon; it is a French name.

Q. The experiments made by him are with direct reference to deodorizing the effete lime? A. Yes, sir.

Q. Is the process upon which he is experimenting to be introduced into your works? A. If it proves to be good it will be. I will not introduce anything permanently except I first cousult with Dr. Chandler.

Q. Have any number of experiments been made upon that process in your works? A. Yes, sir; several times last week.

Q. And those experiments are about to be extended? A. Yes, sir; this week largely—on Monday if all the boxes are ready. We have to get all the apparatus made.

Q. Have boxes been ordered sufficient for the entire amount of effete lime? A. What is made fresh.

Q. Fresh effete lime? A. Yes, sir.

Q. (*By Judge Van Vorst*)—As the boxes are emptied? A. One is emptied at a time every second day.

Q. (*By Col. Hastings*)—There is a considerable quantity of effete lime which has been removed from the Metropolitan purifiers now lying in an exposed state in this City? A. Yes, sir.

Q. There is over 100,000 bushels? A. I should say by this not much more, that is the spent, has no bad smell at all.

Q. During the process of removing the effete lime from the Metropolitan purifiers, as now conducted, is it not exposed to the surrounding air. A. Not more than five minutes—just the transportation to the boat.

Q. When did you adopt this improvement of shipping the lime? A. About five days ago the boats came up.

Q. To what point was it removed? A. Over to Bull's Ferry.

Judge Van Vorst put in evidence the resolutions passed at the meeting of the Board of Directors of the Metropolitan Gas Light Company, on the 24th of February, marked Exhibit D.

(EXHIBIT D.)

At a meeting of the Board of Directors of the Metropolitan Gas Light Company, held at the City of New York, on the 24th day of February, 1869, the following Resolutions were passed:—

Resolved—That it is, and always was, the sense of this Board, that the process of the manufacture and parification of gas in use by this company should be such as to avoid all just ground of complaint on the part of the Board of Health, or of any citizen of New York, referring to a memorial presented by this Board to the Board of Health, August 17th, 1868.

Resolved—That a committee of three members of this Board be appointed with authority and power to put in operation, as soon as can be done, a judicious system of purification, which shall be an improvement on the company's present method.

That in carrying out this resolution, such committee are empowered to adopt such improved system of purification as will prove satisfactory, and to apply the same at the company's works as soon as can be done.

Resolved—That in considering such improvement the committee be governed by the two principal objects, to give the best and purest quality of gas to consumers, and manufactured and purified in such manner under the most recent and best methods, and so as to be attended with the least possible offence or annoyance to the public.

Resolved—That a copy of these resolutions be transmitted to the Board of Health.

Resolved—That Thomas T Buckley, David H. McAlpin, and Robert H. Arkenburgh, constitute such committee.

Attest—WM. MEIKLEHAM, Secretary.

By *Judge Van Vorst:*

Q. Would you suggest the oxide of iron process supplementing that of lime? A. That is what I believed would be the result. We wish to give the best gas and manufacture with the least offence to the public.

By *Col. Hastings:*

Q. How much time is required for the transfer of the refuse lime from the purifying boxes of the Metropolitan Works to the vessel? A. Five minutes.

Q. The entire contents? A. I should say two hours at the most—less than two hours.

Jesse Lissenden, called by the Board of Health, being duly sworn, testified as follows. Examined by *Col. Hastings:*

Y. You are an Engineer of the Manhattan Gas Co., of this city, are you not? A. At that company. Not of the company.

Q. Of the works? A. Yes, sir.

Q. How long have you been employed in that capacity? A. Nearly 15 years.

Q. And during this time you have been familiar with the method of purifying gas— in use at the Manhattan Gas Works? A. Yes, sir.

Q. What is the process used by the company you represent? A. I suppose it is called the dry-lime process.

Q. In what respect does it differ from the process employed at the Metropolitan Works. A. I don't know that it differs at all.

Q. Is the method of ventilating the refuse lime different from that in use at the Metropolitan Works? A. I don't know anything about the Metropolitan Works.

Q. What is your method of ventilating the effete lime? A. By oxidizing the foul gas that remains in the lime after the purification.

Q. State how this is done. A. The cover is first raised from the box and shifted one side.

Q. From the purifying box. A. Yes, sir. Then the exhauster is applied underneath the bottom of the box for two hours. The exhauster runs, I think, about 800 revolutions a minute.

Q. Runs by steam? A. Runs by steam, yes, sir. After that, the men go to work and take out the first tier of plates, which makes an opening right to the bot-

tom of the box on each side, that allows the air to go down underneath, giving free vent right through. After it has worked in that way for one hour it is closed off. We then run the exhauster another hour with an opening in the engine room sufficient to let the fresh air go through the engine room, through the deodorizer, and out of the chimney where all the foul gas escapes. That is supposed to put out all that is not taken out by the deodorizer.

Q. The gas that remains? A. Yes, sir; after three purifiers have been applied, the material in the deodorizer is changed. We never put more than three through it without supplying it with fresh material.

Q. After the effete lime has been through the process you have described is it inodorous? A. I can't say.

Q. What is your opinion? Is it offensive to smell? A. I should think not; no, sir. I could not say positively, for I have never taken particular pains to smell of it. Of course it can't be expected that it will be made as pure as pure air by any process that can be devised.

Q. Why was this change you have spoken of introduced? A. Because there were so many complaints around.

Q. Do you find in practice the improvements you have described successful? A. I believe it gives general satisfaction.

Q. Does it meet the end for which it was designed? A. I think it does.

Q. Since its adoption have there been any complaints in regard to the offensiveness of the refuse lime at your works? A. Well, sir, I have heard some of the bosses complain of it in the works. The men sometimes say that something is not working right.

By *Judge Van Vorst:*

Q. Complain of a bad smell? A. They say so.

By *Col. Hastings:*

Q. Have there been any complaints from the neighborhood in regard to the offensiveness of the foul lime since the adoption of this improvement? A. I don't know that there have; not that I remember.

Q. The only complaints that have reached your knowledge are from the employees in the works? A. Yes, sir. There are various causes, you know, for their finding fault with the smell since the adoption of this new improvement For instance, if the exhauster, instead of running 800 revolutions, is run no more than 400 or 500, you could not expect it to produce the same result as when it runs 800; but if the belt slips we have to stop and take it up. Probably we may run on one purifier only before we detect that the belt has slipped and that the exhauster is not making the revolutions that it should do. Then of course there would not be the amount of suction on that purifier, and the smell would probably be a little bad.

Q. During the process of deodorization, as conducted at your works, can offensive gases or odors be detected outside the works? A. Yes, sir, but very seldom. As this gentleman before me stated, in foggy weather you may find a little smell.

Q. In works now using the dry lime process, what changes would be necessary to introduce the improvement used by the Manhattan Company? A. I don't know. State that again.

Q. In works now using the dry lime process, as ordinarily conducted, what changes would be necessary to introduce the improvement used by the Manhattan Company? A. They would need to have a suction pipe attached to every box in the house—the bottom of it—and then they would need to have an exhauster as we have, and then they want another box in a small building by itself, and a chimney connecting with this box.

Q. Do these changes involve any interruption in the manufacture of gas? A. They need not do so.

Q. Is any additional room required for the use of this improvement? A. Oh yes.

Q. How much? A. The exhauster would take five or six feet square.

Q. Is that all the additional room required? A. That is all that part would require.

Q. Then there is the steam engine. What further room would that require? A. It requires ground enough to build the house for a deodorizer and chimney.

Q. About how much? A. I suppose that building, as near as I can guess, is 20 feet square, or probably more. It might be 25; I could not say positively. Then the chimney, which is 60 feet high, that would require some space.

Q. Do you regard the introduction of this improvement by any company using the dry lime process, as entirely practicable? A. Yes, sir, if they have got the space to put the machinery, and the chimney, and the house on. I forgot to tell you that there is another article attached to that deodorizer—a water concern. That is a new thing which has been put in there within, I can't tell yon positively how long a time, but I should think inside of fifteen months.

Q. Scrubber? A. A kind of washer—something of that kind. I have not seen it. I have been told it was there.

Cross-examined by *Judge Van Vorst:*

Q. About how long would it take to make all these erections. You speak of the chimney; putting up the engine. About how long? A. You have become too tight upon me.

Q. How long would it take your company to do it? A. I could not say.

Q. Could you say about how long? A. No, sir, I could not come within three or four months of it. I would not like to say anything abont it.

Q. Do you think engines could be ordered and all those buildings be put up within three or four months? A. Provided they had men enough.

Q. It could be done? A. It could be done in four months, I think.

Q. All these improvements made? A. Everything.

Q. I want to ask you this question—whether there is any part of your improvement in use by the Manhattan Company, for ventilating the effete lime or the deodorization of it, which is subject to a patent? A. Yes, sir.

Q. Who owns the patent? A. The architect of our works. His name is Farmer.

Q. You say that there is some unpleasant smell about the works? A. Occasionally.

Q. Do you know of any method of the manufacture or ventilation of gas, except there would be some smell about it? A. I do not.

Q. The object of your company has been so to purify it as to have the least possible smell? A. Yes, sir.

Q. When this system of ventilation you spoke about is in use, there is on some occasions an unpleasant smell? A. Yes, sir.

Q. Especially as I understand you to say when the air is moist and heavy it drives the odors which come out of that chimney down to the earth? A. I suppose so.

Q. And at times the bosses about your establishment have complained of smells—about smells? A. Yes, sir.

Q. (*By Col. Hastings*). You say Mr. Farmer has a patent? A. Mr. Farmer has a patent on the exhauster.

Q. The method of purification is the same in use as at the Metropolitan Company, except in the matter of ventilation? A. I suppose so, I have not been there.

Q. The only difference is the supplementary process of ventilating of the effete lime? A. Yes, sir.

Q. Your company has not the exclusive right to use any portion of the machinery you describe? A. Not that I know of.

Q. (*By Judge Van Vorst*). Do you think they have not? A. I know there has been one manufactured and put up outside of our works in the city. I think it was for a different purpose—tor blowing fires.

Q. The question which Col. Hastings asked you, and which I should like to have you answer was this: Whether the patent is owned by the Manhattan Company? A. It is owned by this man Farmer. The company have nothing to do with it that I know of.

Q. Do you know what other companies in this city use the dry lime process, except the Metropolitan and the Manhattan. How does the Harlem purify? A. I don't know.

Q. (*By Col. Hastings*). Are you familiar with the oxide of iron process? A. I am not.

Q. So far as you know, your company is perfectly willing that other companies should adopt the improved system of ventilating lime? A. So far as I know.

Peter Cartwright, called by the Board of Health, being duly sworn. testifies as follows:

Examined by Col. Hastings.

Q. Are you in the employ of the New York Gas Company? A. I am.

Q. In what capacity? A. As practical engineer.

Q. How long have you bten so employed? A. For twenty years.

Q. What process of purifying gas is in use by that company? A. The iron process.

Q. State in what form the iron is used in that process? A. The iron ore we get from Staten Island, and with it is placed a percentage of iron borings and turnings, and we mix the mass with ammoniacal liquor to oxidize and prepare it for use.

Q. How long has this process been used in your company? A. Ten months.

Q. What process was in use by your company previous to this process? A. Dry lime.

Q. What changes were necessary in the introduction of the present process? A. Well, very little changes indeed—introducing a new bottom with skids of wood.

Q. New bottoms to the purifying boxes? A. Yes, sir, that is a superficial bottom to receive the iron oxide.

Q. How much time would be required to make this change in any gas works using the dry lime process? A. About 5 hours in the putting in the new bottom and be ready to turn on again when the lime was fouled—that is the way we turned on ours.

Q. If a gas company using the dry lime process had a double set of purifiers would this change to the iron process involve any interruption in the manufacture of gas? A. Not at all; with only one set it would not.

Q. How does the iron process as used by your company compare with the dry lime process in respect to offensiveness? A. Our house is now like a bed of roses to what it was when we used lime.

Q. Your company found the dry lime very offensive? A. Yes, sir, very indeed.

Q. And was it that cause that led them to the adoption of the iron process? A. It was, and to comply with the law.

Q. Is the iron process used by your company practically inoffensive? A. There is no offensiveness whatever about it.

Q. Does the gas manufactured by your company suffer in illuminating power in the use of this method? A. I don't know to my knowledge. Some say it does, and some say it does not.

Q. Do you know how your company regard the iron process; whether as a success or a failure? A. They consider it a success.

Q. Do you know whether they have any intention of modifying or changing the process they now use? A. I do not.

Q. How does the process used by your company compare with the dry lime process in respect to expensiveness? A. There is great economy in the iron process. I think it will save our company this year $13,000 in lime alone—material alone. The labor is not so much, because of the offensiveness of the lime in winter, when we were making our greatest consumption. We had to employ a double set of men sometimes, and men would be knocked over, and then we would have to employ men in their places and pay them too. I have picked them up and carried them out myself.

Q. When you were using the dry lime process? A. Yes, sir.

Q. Knocked down by what? A. The offensive smell.

Q. How many instances of this character do you recollect? A. I could not tell how many, there has been so many. I have picked them up myself and carried them out. One day the lime man was bringing in a load of lime, and the man was going over when our men caught him, or else he would have gone over and the horse and cart would have gone on to him. The horse fell down and we had to take him out of the harness and take him out in a lot.

Q. Men and horses were afflicted in the way you describe when the lime was being removed from the purifying boxes? A. We had broken into them then for ventilation, and the fumes starting out of the house met them. We had to let them stand for four or five hours before we could get the lime out.

Q. Is any additional room required for the use of the iron process? A. No, we made no additional room. It would be better with additional room, certainly, or else in a shed or out-building.

Q. Can the oxide of iron be revivified in the open air, or do you require a building for that purpose? A. It can be revivified in the open air, but it is better if you could protect it in storms. Of course it is better if it is protected from the weather.

Q. Is any odor given off from this iron mixture during the process of revivification? A. Not at all.

Cross-examined by *Judge Van Vorst:*

Q. How long has this process of purification by your company been used? A. For 10 months.

Q. Before that you used dry lime? A. We did.

Q. How long have you been an Engineer there? A Twenty years.

Q. And were you an engineer during the time they used the dry lime? A. I was.

Q. Is any part of the process of this purification by the oxide of iron patented—have you got a patent for it? A. We have.

Q. From whom did you get the patent? A. From the parties at Washington.

Q. Who owns the patent? A. Me, for one.

Q. Do your company? A. Me, for one.

Q. You are interested in the patent? A. I am.

Q. And you think well of that process? A. Yes, sir.

Q. There is no smell of gas from the fouled iron? A. There is not.

Q. It is pleasant, on the other hand? A. Yes, sir, I think so.

Q. Does it deliver as pure gas as the gas purified by the lime process? A. I don't know of my own knowledge.

Q. Does it take out the carbonic acid? A. In a great measure it does. In a small measure it might not.

Q. Does the presence of carbonic acid increase or diminish the candle power? A. I should think it diminishes it a little.

Q. Then the gas delivered purified by the oxide of iron has not so great an illuminating power as that which is purified by the lime process? A. I think it would if the lime and the iron process was carried the same distance. I think the iron process would retain its luminosity for a greater distance than the lime process.

Q. Do you mean to say that? A. I do.

Q. I ask you this question: Does the iron process take out all the carbonic acid? A. No, sir.

Q. Therefore, it does not purify quite so well as the lime in that respect? A. No.

Q. In respect to taking out carbonic acid, the iron

process does not take it out as well as the dry lime? A. It does not.

Q. In order to get this right to purify with the oxide of iron we must get the right from you, must we not? A. For what?

Q. We must obtain the right to use it from your patent? A. Certainly.

Q. From you? A. Certainly.

You say you never heard any complaint made about bad smell since the oxide of iron was used there from anybody A. From anybody.

Q. Have you heard no complaint about the gas delivered? A. I have seen it in the Press.

Q. What have you seen in the Press about it? A. Why, saying that the gas burned blue, &c.

Q. That the gas burned blue, &c.? A. Yes, sir; I did not see that, but I saw the words of Prof. Wurtz here, who made use of those words. I did not see it in the Press myself before that.

Q. Haven't you heard complaints made of that gas, that its candle power was diminished? A. I have.

Q. You have heard those complaints? A. I have.

Q. That the candle power of the gas purified by the oxide of iron was diminished? A. I have heard so.

Q. Repeatedly? A. Yes, sir.

Q. From consumers? A. Never. Not a word from consumers.

Q. From whom? A. From opponents of the oxide of iron process.

Q. From those who were opposed to the purification by the oxide of iron process you have heard that the candle power was diminished? A. Yes, sir.

Q. Don't yourself think it is diminished a little? A. I do not.

Q. Don't you think the candle-power is diminished some? A. I do not.

Q. Not at all? A. I do not.

Q. Not in the least degree? A. I do not, to my knowledge.

Q. After the iron is taken out of the purifiers, what do you do with the foul oxide of iron? A. Throw it out on the floor.

Q For what purpose? A. To oxidize it.

Q. Is there nothing given out; are there no emanations proceeding from it? A. No smell.

Q. Are there no emanations proceeding from it? A. Yes, sir.

Q. There must be some emanations? A. Yes, sir; there is a vapor rises from it when in the state of oxidation.

Q. There must be room of course to have this iron after you have taken it out of the purifiers, to ventilate it? A. Certainly, must have room, of course.

Q. Do you know how the Harlem Company purifies its gas? A. I do not, from my own knowledge; I heard that they purified with lime, that is all I know about it.

Q. Dry lime? A. I have heard so.

Q. Have they got any ventilator? A. I don't know.

Q. Are you taking measures to introduce your patent throughout the country—this process of purifying gas by iron? A. Will serve anybody who will take it.

Q. Are you or are you not taking measures to introduce it? A. We are not.

Q. You are doing nothing about it? A. We never applied to anybody, or to Mr. Zollicoffer, nor any other parties around New York.

Q. Have you advertised it? A. We have.

Q. You are doing it now? A. We are not.

Q. You have advertised it lately, have you not? A. I should think not for four or five months.

Q. You have advertised the sale of the right to use it? A. Certainly.

Q. And you are doing it now? A. Yes, sir.

Q. To any person who wishes to buy it? A. Yes, sir.

Re-direct Examination by *Col. Hastings:*

Q. How came you to make the invention spoken of? A. We tried to comply with the law and to destroy the offensive odors around the works.

Q. You were making experiments to that end? A. Yes, sir.

Q. Relating to the removal of the offensiveness by the old process? A. Yes, sir.

Q. Under what auspices were you making such experiments; under whose directions or request were you making those experiments? A. The request of the President of the Company.

Q. Of the New York Company? A. Yes, sir, Mr. Adam.

Q. Were those experiments satisfactory to the Company? A. They were glad to get hold of it.

Q. And for that reason the process was introduced in the New York Works? A. Yes, sir.

Q. By whose advice, if any, did you obtain a patent upon the process? A. No one's advice; only we advised each other; two of us were associated, William H. St. John and Peter Cartwright.

Q. You obtained a patent, I suppose, because you required it, as a valuable improvement and a success? A. Yes, sir.

Q. Has the New York Company any interest in the patent? A. Not a cent.

Elisha Harris, M. D., being called for the Board of Health, being duly sworn, testifies as follows. Examined by Col. Hastings.

Q. State if you please your profession and residence? A. I am a physician and reside in West 42d street.

Q. How long have you been in that profession? A. For the last 20 years, sir.

Q. And in what professional relation are you at present employed? A. Sanitary Superintendent of the Metropolitan District.

Q. Have you read most of the testimony adduced in the hearing under the order relating to the Metropolitan Gas Company? A. I have read about two-thirds of all the testimony that was given prior to your sitting to-day, from the first.

Q. In addition to the examination of the evidence referred to, have you given the subject of the best method of purifying gas any study or attention? A. Only so far as connected with the questions of sanitary improvement in cities, where these questions have been already examined, and in connection with the progress of chemical knowledge, as these questions illustrated some of the leading facts in the chemistry of gases.

Q. Do you know what gases, if any, are given out from the foul lime removed from the purifying boxes of any company using the dry lime process? A. The gases which are given out in such a manner as to be the object of special examination and remark by sanitary officers and physicians, are mainly the sulphuretted gases and undefined and unestimated amounts of the compounds of cyanogen, but chiefly the sulphuretted gases, the sulphide of ammonium being evolved after a time when the fouled lime is exposed to the atmosphere.

Q. Are any of the gases escaping from such fouled lime recognized by sanitarians as injurious to life or detrimental to health? A. Yes, sir; all the compounds or complex sulphur gases, except sulphurous acid in vapor, which is not to be mentioned as a gas, are recognized as directly injurious to health, the sulphide of ammonium being the most poisonous of the sulphur gases which are known to sanitary science; the experiments with these different gases being too incomplete to enable us to compare them relatively, we can speak of the sulphuretted hydrogen and the sulphide of ammonium as being chiefly the obnoxious gases evolved from the foul lime when exposed to the atmosphere.

Q. What evidence is there that sulphuretted hydrogen gas is dangerous to health? A. First the large number of accidents from respiring the gas have abundantly proved that it is fatal to life when it exists in a certain percentage in the common atmosphere, or in the atmosphere of any room or place; then a great variety of experiments with small animals which have been very decisive in their character; and thirdly, observations upon persons who are compelled, from their vocations or by any accident, to breathe sulphuretted hydrogen for any considerable period day after day in their vocations; all these go to prove the same thing, that the sulphuretted hydrogen is injurious to health, and the experiments prove that a small percentage will destroy life; a percentage, however, of one per cent. does not necessarily destroy life, but whenever the percentage has been increased from point to point in the scale, the various animals that have been subjected to it have been killed. The list of experiments given in this volume which I have in my hand——

Q. What volume is that? A. This is Hammond's Hygiene.

Q. Is it a standard work? A. Yes, sir; this is a brief list; and, if you desire, a more complete list of experiments could be presented immediately, but this briefly shows about how the case stands. I will read from page 156: "Sulphuretted hydrogen is exceedingly poisonous. Dupuy *père* found that 1-800 of this gas was sufficient to render the atmosphere so poisonous that small birds were killed in a few seconds when subjected to its influence. One part in 299 parts of atmospheric air proved fatal to a dog. Chaussier found that one part in 250 of air sufficed to kill a horse."

Hammond further says: "The results of my own experiments with sulphuretted hydrogen do not differ materially from those other observers. I found with Dupuytren that all small animals, as birds and mice were killed by a smaller proportion of gas in the atmosphere in which they were confined, than larger animals. Sparrows and mice did very well in an atmosphere, 1-1000th of which was sulphuretted hydrogen. With more than this death ensued, though not until 20 or 30 minutes had elapsed." These were carefully made by Dr. H., who is a distinguished physiological experimenter. He continues: "On post-mortem examination the blood was found perfectly dissolved, and the blood corpuscles completely broken down. The action of sulphuretted hydrogen when not inhaled in a large quantity, appears to be that of a narcotic poison. Its effects upon the organism when its action is long continued in a small amount, has not been so thoroughly investigated as is desirable. That it is capable of producing injurious results is very certain. * * * * Dr. Taylor, the author of a work on Medical Jurisprudence, refers to instances which occurred as to the poisoning by this gas of workmen engaged in excavating the Thames Tunnel, by respiring the atmosphere of this place. The strongest fellows were in a few minutes rendered extremely weak and several died."

All the evidence regarding the operation of the poison upon the blood being so very important, that sanitary officers have felt it necessary to ask for special experiments. A series of experiments on a large plan have been in progress for two years under the Health department of the Privy Council of Great Britain upon his and various allied subjects, and some of the results of these experiments have also been published, much more conclusive than these older and more general experiments.

Q Well, do the conclusions established by those experiments all tend to the same end? A. They all show that these sulphuretted gases destroyed the blood corpuscles, which have always been recognized as constituting the most essential element in the whole range of the physiological constitution of the living body. To know just what kind of changes occur in the blood, while circulating under and exposed to the influence of these gases, has been one of the nicest and most exact kinds of chemical inquiry that have ever been pursued.

Q. What other gases escaping from fouled gas lime would you consider obnoxious to health? A. The sulphide of ammonium is the asphyxiating gas of all others which is recognized as being the most quickly destructive to life, and it is combined in the gases which float off from the fouled lime, so that no ordinary observation, I suppose, could state which was in excess, but the special odor of sulphide of ammonium is far the most offensive. That is the gas that usually so quickly destroys life in persons who chance to go down into deep privy vaults, as scavengers, and that class of persons who have suddenly died on going into privy vaults—accidents that have actually occurred in this city, and which are recurring all over the world amongst scavengers.

Q. As a sanitarian will you state what is your opinion as to the danger to the public health from the presence of the fouled gas lime within the limits of the city of New York? A. If gas lime is exposed to the atmosphere it will give off these deadly gases, and the sulphide of ammonium with certainty coming, that is derived from the sulphide of calcium, which exists always in abundance in the fouled lime, and it will float in the common atmosphere until such transformations have occurred as destroy its character, as sulphide of ammonium will float in the direction in which the wind is blowing, which is a fact well certified to by experiments, and in particular states of the atmosphere as regards temperature and barometrical pressure it may float far over the city—so far as to become dangerous to health to a great distance. Again, the gas itself is judged to be more obnoxious at the distance of a few blocks from the mass of lime from which it is evolved, than it is immediately on the premises. My own observation fully confirms that as regards the effort to discover the localities within which this gas can be recognized by its odor, and effect upon the respiration. I have smelled it as far eastward as the top of Murray Hill on Madison Square, and as far southward as 14th street, and frequently in West 42nd street, where I reside.

Q. Have you ever been able to trace these odors to their source? A. Yes, sir; I was able to trace these odors without being at the time able to gain access to the fouled pile of lime, some years ago when the dry lime method was used in the works on the east side of the city. I do not think that to be a demonstration which would answer any positive purpose of a public statement, but to me it was entirely conclusive. Following merely the odor, ann noticing the direction of the wind at the time.

Q. To what distance did you then follow the odor? A. I then resided one door north of the Rev. Dr. Bellows's church.

Q. On what street? A. Between 20th and 21st streets. I should think it must be a mile to the gas works, perhaps three-quarters of a mile to the nearest gas works, and I then made observations which satisfied me that the 14th street works gave off the nuisance quite as abundantly as those that were near to my residence; and more recently, and last summer, when peculiar circumstances rendered it easy to follow any particular odor, from changes that had occurred in the atmosphere, making it peculiarly pure, and reducing the temperature by the change of the direction of the winds on the 5th day of July—I deemed it a duty to follow this kind of evidence up to its source, and asked one of the Sanitary Commissioners to join me, and in that case I was able to follow the odor directly to its source in the Metropolitan Gas Works.

Q. From what point to what point? A. I observed the odor first at about 30th street, while walking up Broadway. On reaching my house in West 34th street, between 5th and 6th avenues, the odor was so oppressive in 34th street that I endeavored to follow from that point, and following from 34th street, I went with the Sanitary Commissioner, who joined me for the purpose, to the lime heaps which were then freshlyc overed with the foul lime that had been thro wn out.

This observation was made for the purpose of satisfying our judgement on the precise source of a particular odor and to see it with our eyes. There was then no intention of making it the ground of special complaint, because other companies in the city were known to be using the dry-lime process of purification, but here was an opportunity to settle unequivocally a fact which was important to know.

Q. You found the source at that time to be the heaps of fouled lime of the Metropolitan Gas Works? A. Yes, sir, unequivocally.

Cross-examined by *Judge Van Vorst:*

Q. Have you given the subject of the purification of gas practically any attention? A. I have given it only that kind of attention practically which a person interested in sanitary knowledge must give if he would understand the source of impurity in the atmosphere, and the merits of questions which have become important in all great cities where gas manufacturers are located in the midst of the population. These questions are important in all the great cities of the world at present.

Q. You have given some attention to the subject of the merits of the respective method of purification in use, theoretically, have you not? A. Yes, sir.

Q. Now, Doctor, as the result of your own investi gation, which is the better purifier of the gas—which eliminates from the gas the most foulness; the oxide of iron or the dry lime method of purification? A. Neither process perfectly purifies the gas from what you technically denominate impurities!

Q. I ask you which of those two processes is the better purifier. I am not asking you whether any process does perfectly, but which of those two processes is the better purifier. A. I will answer your question directly and catagorically as you put it, if you allow me to refer to substances instead of processes. For as regards these two elements—natural elements—they are things and not processes. If taken alone, either process would be objectionable, but if I am to answer that question as relates to these things I would say positively that lime will remove the largest amount of certain impurities, and hold those impurities ready to yield up again in another poisonous form, and iron will remove positively the same impurities, but not all of the same—the worst of the same—and will fix those impurities and not yield them up in a poisonous form. So that regarding them as processes, there is first that difference to be stated and that fact to be stated. Then we have to commence anew with the fact how to proceed to finish the task of purification.

Q. Could you suggest any improvement upon the process or method or thing or whatever you call it in use at the New York Company for the purification of its gas? A. I have not seen the New York process; I know those only by name.

Q. The oxide of iron process, which is the only process in this city covered by a patent; could you suggest any improvements in addition to the use of the oxide of iron as it is used there? A. I have not seen that, though I have been invited; I have been unable to give any attention to either process, and in my judgment, the oxide of iron process as used there has gradually diminished the offensiveness which people usually complain of in the neighborhood of gas-works, but I don't know the extent of the completeness in the puri fication of the gas itself.

Q. But the gas itself, as delivered to its consumers, is not as thoroughly purified of sulphurous compounds as that which would be delivered by the lime process, do you think so, speaking chemically and theoretically? A. There must be used, in addition to the iron process, however, that is used, some alkaline earth, or substance, or fluid that will receive and recombine certain impurities which the iron does not fully control.

Q. How would you suggest a little of the hydrate of lime as a supplement to it? A. That is found by experience, to finish the job well.

Q. If the hydrate of lime in a moist form is used and not over-used, the quality of the gas that is burned is of the very highest that is known among gas manufacturers? A. Such is the testimony of hygienists who have examined it, and no offensiveness is caused among the community in which the gas is made; but the hydrate of lime must be used after the iron process or you will have the offensiveness, because the iron is used merely to fix certain things which are very diffi cult to control, viz., these sulphur compounds which go to form the sulphide of calcium, etc., in the lime process, but then here is the carbonic acid gas which must be controlled in order to give the quality that is needed to the gas; there is a residuum of sulphur which needs to be withdrawn if possible; the experiment of withdrawing it by secondary purification, I believe, has resulted triumphantly in several instances.

Q. In order to put this thing in a practical form, oxide of iron does not thoroughly remove the carbonic acid, and there is still in the gas a residuum of sulphur, so I understand you to say? A. Certainly, sir.

Q. And which, if it was subject to a supplementary or subsequent process of purification by the hydrate of lime, you think it would remove that carbonic acid and the residuum of sulphur the iron had failed to take out? A. The supplementary process with lime properly presented to the gas for this second purification, is said to be entirely triumphant, and the gentlemen who have certified it have undertaken the inquiry so intelligently and so conscientiously for hygienic purposes, that I would like to present it as an item of evidence.

Q. I would like to ask this question, whether there is any danger by subjecting the gas to this subsequent action of the hydrate of lime, after the iron has acted upon it or enfeebled the illuminating power of the gas? A. Of course there would be, unless the chemist was master of the situation and knew his trade.

Q. What effect does the presence of carbonic acid in the gas which the oxide of iron fails to eliminate, have upon the illuminating power of the gas when combustion takes place generally? A. I must say that practically I could not answer that question, and I merely state it upon the authority of chemists. It is not necessary that I should commit to paper any of the evid ence, as it would not be original. It is but a small item, and imperfect as my own chemical knowledge might be, I would undertake to get out the carbonic acid gas without damaging the gas.

Q. Don't chemical writers say that the presence of carbonic acid in the gas, when combustion takes place, diminishes its candle-power; don't writers upon chemistry say that? A. They do, and display weakness on the spot when they say it, unless they show how that carbonic acid gas can be withdrawn.

Q. You have suggested a way to get rid of that by the use of hydrate of lime supplementary; I call your attention to a process where the hydrate of lime is not used at all subsequently? A. I have answered the question.

By *Col. Hastings:*

Q. Do you know of any authority recognized as such among sanitarians that discusses the question of these poisonous gases escaping from fouled gas lime upon the blood or health? A. I do.

Q. What? A. As I stated in the opening evidence upon the medical question, the blood does suffer directly when exposed to these gases. I wish now to state that sanitarians have undertaken to find how it suffers, and whether such poisons can be resisted, because it is essential when studying the causes of diseases to find out what are inevitable poisons acting on the blood, and it turns out rather unexpectedly to some medical inquirers that there are gases which are in a very absolute sense poisonous. The carbonic acid gas has long since been found to be only contingently poisonous. It destroys life; but it was not the poison which could always be asserted as the source of particular conditions of ill health which were discovered in foul places What were the other gases was the question, and what kind of gases; and in this inquiry which is now in progress, and probably will be for several years by the Medical Department of the Privy Council of Great Britain, which is the last report of the second installment of the chemical evidence on this very subject of the effect of certain exhalations, vapors and gases upon the blood, on the subject of physiological and pathological questions connected with these chemical and natural forces—this item of evidence occurs bearing directly upon the question you ask. The essential elements of the blood corpuscles, which is most prominent and unyielding to all other effects which disease produces is the Hematocrystalline that enters into the constitution of every blood globule, and constitutes a la g percentage of it. In that Hematocrystalline is combined all the iron that floats in the blood. The Hematocrystalline has become the subject of most careful study, with reference to the changes therein gases produce. Now it is found that carbonic acid gas does not at once destroy Hematocrystalline. It is found that most of the poisons that are introduced into the body will break up the blood globules and still leave the Hematocrystalline to crystallize as Hematoidine. We have had occasion to study the Hematoidine in the investigation of last summer, and the history of its persistent life as an element in the fluids, even of sick animals, is an interesting fact. But certain gases act upon that Hematocrystalline and eliminate it so that it cannot be constructed into any of the forms of life in the animal tissues. Tht destruction of a very persistent and important element therefore of the body comes to be a specially important fact in hygiene, for we have been hunting for years for methods of exact demonstration of hygienic questions, and now it is done at the expense of the Lords of the Privy Council in this class of studies on a large scale. I will read from the Tenth Report of the Medical Officer of the Privy Council, London, 1858, at page 170. "A diminution of Hematocrystalline in the body constitutes the disease termed chlorosis or anaemia. It is either a specific element or a symptom and consequence of chronic disorders, or particularly tropical fevers." * * * "The Hematocrystalline is the last ingredient of the blood which undergoes putrefaction. Its stability is the main factor in the stability of life. This quality is perhaps mainly the result of the power which it possesses of taking up oxygen from the air, and yielding it again to other matter in contact. * * * * * "Hematocrystalline combines readily and more pertinaceously than with oxygen, with number of these gases, such as carbonic oxide, sulphuretted and phosphuretted hydrogen. * * * * The hermatocrystalline is the last ingredient of the blood which undergoes putrifaction. It preserves its color and spectrum for years, in a horribly offensive mixture."

Q. That kind of evidence has this value in answering this question which has just been asked—that it is reducing to demonstration what hitherto had been stated in the way of assertion? A. It is showing how a change occurs, and in order to show how the highest resources of chemistry are brought into play, namely, spectrum analysis, and show the beginning and progress and ending of certain changes which occur when the blood is exposed to certain poisonous gases; and the result of this inquiry shows that certain gases and these complex sulphuretted gases and the phosphuretted gases and a large number of others, and compounds of cyanogen gas come into the same list, instead of merely dissolving and breaking up the blood globules actually destroy the chemical constitnent which in most diseases fails to get destroyed, so that the sanitary fact begins to be settled as a demonstration that certain gases should not be permitted to be evolved in a great quantity into the atmosphere which people breathe. Not that the people will be immediately killed, but that their health will be silently and persistently injured from a cause which no science before had perfectly controlled. Now chemistry comes in with its exact methods of demonstration, but not until these higher applications of it by the beautiful method of the spectrum-analysis had enabled us to get down to the 1000th part of a grain and study it with the interest with which we could formerly study larger quantities.

By *Judge Van Vorst.*

Q. The effect, I suppose, would be the same if these poisonous gases were evolved in the dwelling-houses where combustion of the gas takes place? Oh yes: it makes no difference where the gases come from if they are only there when people are respiring.

Q. If those foul, poisonous gases are not eliminated in the act of purification, they do appear in the dwellings when the combustion of the gas takes place? A. No, sir, they do not in any perceptible quantity, for even sulphur appears as sulphurous acid.

Q. Isn't that poisonous? A. Sulphurous acid is a poison only contingently. It does not even destroy the blood corpuscles, as it is presented to us in our respiration. It partakes of none of the qualities which I have described concerning the truly poisonous gases.

Q. Does is depreciate property? A. I have no doubt of that, because it will tarnish silver. That is not a sanitary question, however, it does not concern hygienists.

Q. Which do you suppose to be the worse, free sulphuretted hydrogen, or sulphide of ammonium free? A. Sulphide of ammonium, far worse.

Q. Have you ever heard of any person being killed by sulphide of ammonium? A. I have known of cases and they are very numerous; they are known in common life as suffocation and asphyxia.

Q. Occurring under what circumstances? A. Occurring generally in old privys and similar situations, but there are cases which can be referred to as having occurred in a specific manner in gas-works; I need not adduce cases, because they are abundantly verified.

Q. Can there be any sulphuretted hydrogen at all given off by the waste lime, if the prominent odor on opening the purifiers is that of ammonia? A. Yes, sir; I have been present when gas purifiers were opened and the predominating odor is sulphurous, and the ammonia is dissipated as the men are taking away the lime; and the lime which I have myself handled twelve hours after it had been thrown out has grown hot on exposure to the ordinary current of air. One week ago to-day I made the experiment, and the sulphide of ammonium was eliminated in a very offensive and considerable volume, and I was told that the lime had laid nearly twelve hours where it was in a mass; but there was no odor of ammonia there then, but had I been present at the opening there would have been an odor of ammonia perceived.

Q. And the odor would have predominated? A. I suppose it would, so far as my senses were concerned; it is one of the most pungent of gases to the senses; it naturally would be predominant.

Q. Notwithstanding all that, and conceding that the predominating odor is that of ammonia, you do think that there may be sulphuretted hydrogen given off by the waste lime? A. I think so; but I have not made exact tests of that question; I believe it is a fact conceded that it is given off.

No further testimony offered.

PROFESSOR HENRY WURTZ

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